THE SCIENCE TEACHER

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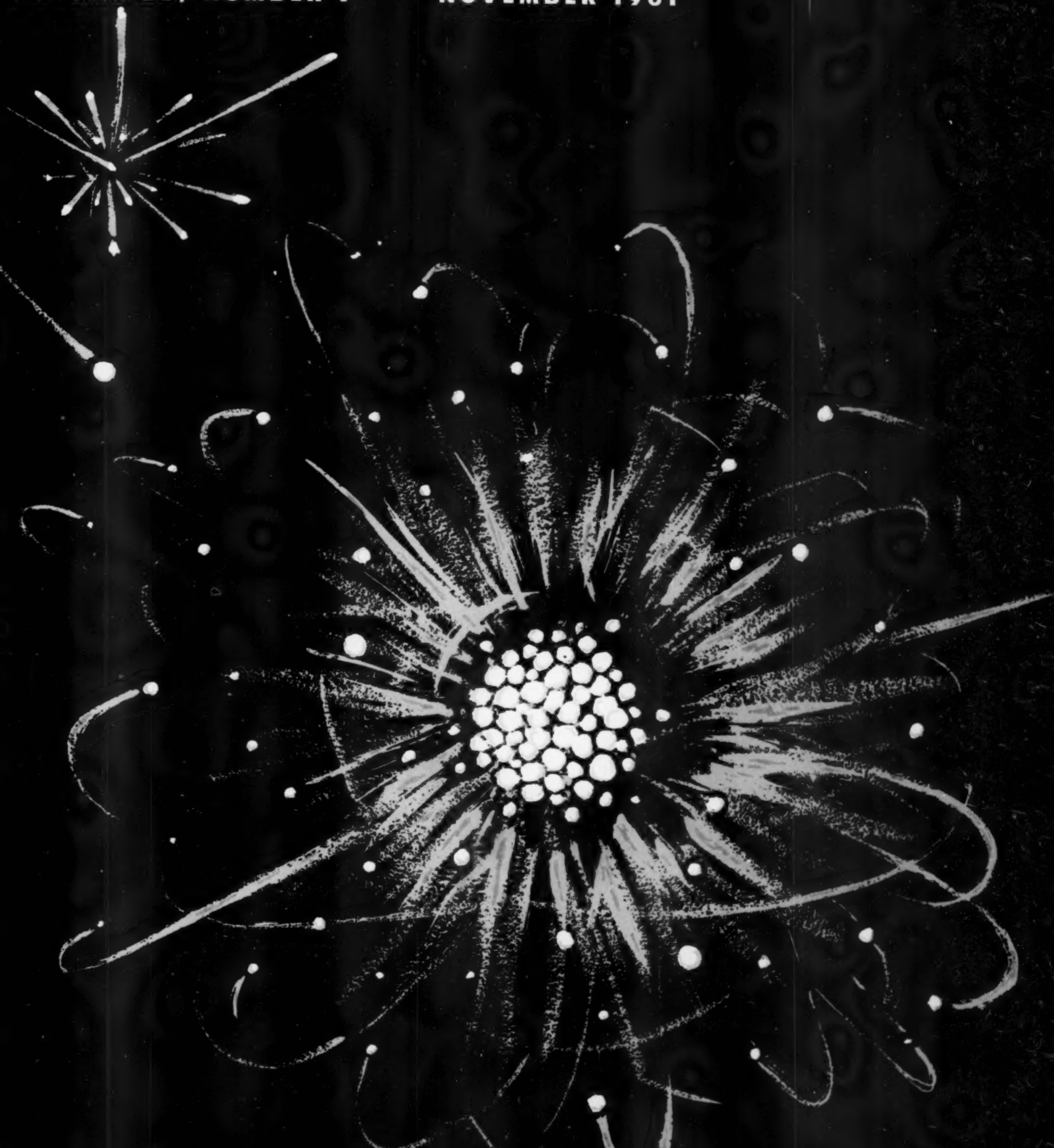

THE SCIENCE TEACHER

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The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association

Volume 28, Number 7 · November 1961

Editorial

Today there certainly is no dearth of proffered help for science teachers. At least two dozen groups or agencies are "in the act," one way or another, on a national scale seeking to help strengthen science education by improvement of the quality of teaching and learning. All of us are caught up in "the pursuit of excellence," but all too often, the pursuit becomes a mad rush to "do something, even though we are not sure that it is right." Reasons for this, perhaps, are that we seldom take time to think and spell out what is meant by excellence.

As science teachers, we should be more prone to "look for the evidence" than most of our colleagues. Now what is the evidence through which we gain greater excellence, if we do the following? (Bear in mind, this is not written to be critical; but simply to ask for examination of *the evidence*. The alternatives are stated or implied.

a. Transfer biology bodily and boldly from grade 10 to grade 9.
b. Teach CBA chemistry rather than the "conventional" course.
c. Require every teacher in grades K-6 to teach science in a self-contained classroom.
d. Drop conventional general science in grades 7-9 in favor of life science, earth-space science, and physical science (or some other sequence).
e. Purchase and use a 130-film set (plus or minus) of motion pictures for teaching biology, chemistry, or physics.
f. "Toughen up" through more frequent and lengthier homework assignments, or required exhibits for a science fair, or collateral reading, etc.

In order to judge excellence, there must be established standards or a base of reference; we must establish some values before we can have evaluation. In my opinion, this means first of all a carefully thought-out philosophy for science teaching and clearcut notions of what our objectives are. It means recognition that science as a course of study in elementary and secondary schools is *general education* for all of the students and *pre-vocational education* for five to ten per cent. It means that science as a discipline has a history (the products of science), an active present (the processes of inquiry and the modes of thought), and a future (the uses, applications, engineering, and technology); also, that none of these three aspects could exist without *people doing*—and the people are chemists, geologists, mathematicians, oceanographers, engineers of various kinds, teachers, etc.

One other point: from my own view, teaching for *"understanding* of the nature of the universe, man, and other things" is not enough. This is too passive, too ivory-towerish. We must teach for action, for behavior, and for thinking and doing.

As a suggestion, how would you react to these purposes or intentions or reasons for teaching science?

1. To develop functional control over the major concepts, principles, and "big ideas" of science—the kinds of learning that are not fleeting (such as detailed facts and formulas) but will "last" for the next ten years and more.
2. To develop understanding of and ability to use modes of thought and processes of inquiry commonly employed by practicing scientists.
3. To develop appreciation of the scientific endeavor and its findings as a civilizing, humanizing force.
4. To help keep the pipelines filled with tomorrow's scientists, engineers, technicians, and science teachers. (Perhaps the last should be first, it is so neglected in counseling and recruiting.)

If I seem to overdo the matters of philosophy and objectives, it is because of their fundamental importance. What you believe or accept (consciously or otherwise) about purposes and reasons for science being in the curriculum points the way to—

—Why you teach science
—What you select to teach
—How you go about teaching it
—How you do your counseling
—How you go about testing

Life as a *science teacher* can take on new challenges, develop new satisfactions if we determine to teach every minute so that *our objectives are showing*. Basic to this is the requirement that we re-think our philosophy of science education, a job that never ends.

Robert H. Carleton

Annual Joint Meeting of NSTA with other Science Teaching Societies . . .
At the 128th Meeting of the American Association for the Advancement of Science
December 26-30, 1961, Denver, Colorado
. . . See Page 49

THE SCIENCE TEACHER

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MEMBERSHIP

The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

Regular Membership	$ 6.00
Sustaining Membership *	10.00
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Life Membership *	175.00
Payable in ten annual installments; $150 if paid in three years or less.	
Library Subscriptions *	8.00

* Includes the *Elementary School Science Bulletin* published monthly from September through April of each year.

As an elementary teacher and a member of your Association, I needed some help relevant to reports for a summer school college class on the new curriculum courses (CBA, CHEM, and PSSC).

Your reply and service were very rapid and the information sent served my purpose. If you ever want a testimonial as to the value of being an NSTA member, let me know.

William Pierce
812 West Street
Emporia, Kansas

FSA Progress

Our Future Scientists of America Club (Tri-Sci Club) here at Livermore has had a very successful year to date. We plan on expanding our membership from forty to sixty at the beginning of the new semester.

Marsha Johnston
Livermore High School
Livermore, California

We have just completed our first year as an FSA charter member. We began as a very small group with no background in science. Since the membership has increased, however, and the students have one year of science now, we hope to do more things in the coming year. The work of FSA has been invaluable to us in stimulating interest for science.

Iris H. Shinseki
Wainae High School
Oahu, Hawaii

As Club President, it is a pleasure to report on our first year as member of the FSA Club.

Through our activities, it became possible to enter the Annual School Science Exhibition, and many of our members received prizes for their science projects. We have a full program for the 1961-62 school year.

Miguel Ortiz Pico
Cayey High School
Cayey, Puerto Rico

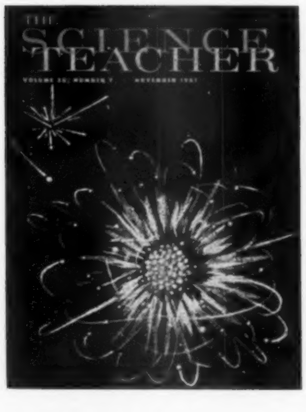
Overseas Exchange

I have been directed by the American Embassy in India to write you.

First, I would like to join NSTA. This would entitle me to receive materials on the latest developments in the teaching of science in the U. S. I am working as Senior Science Master, teaching physics and chemistry, in an English medium public school.

Secondly and most important, could you please insert a small announcement in your periodical on my behalf. I would like to correspond with fellow teachers from across the seas on matters of common interest. It would keep me supplied with new ideas. In return I will keep my friends informed about India and her changing conditions. Could you please do that for me?

M. P. Singhal
Wynberg-Allen School
Mussoorie, U. P.
India



THIS MONTH'S COVER . . .

Final proof of the presence of Lawrencium, Element 103, was made through a series of experiments at the Lawrence Radiation Laboratory operated for the Atomic Energy Commission by the University of California at Berkeley, California. Experiments with the first element to be discovered solely by nuclear methods are described in the lead article on page 6.

The disturbance caused in the nucleus from bombardment and the activity created by the escaping atom particles are portrayed in the cover presentation. The artist, Phyllis R. Marcuccio, is a staff member of the Association.

NEA NOTES

EDITOR'S NOTE: From time to time, we will report events and data of interest from the other NEA units in this column. Additional information on the items reported may be obtained by writing the individual groups listed under each item.

Study on Digital Computers

The National Council of Teachers of Mathematics, a department of the NEA, has received a grant from the International Business Machines Corporation for the preparation and distribution of a series of publications on digital computers to enrich the high school mathematics program. The emphasis will be on the fundamental mathematics involved in computing, and the purpose is to motivate the learning of mathematics. One series of publications will be designed as text or enrichment material with separate publications for the teacher and student. Another will cover careers in data processing. The third will be designed to act as a source guide for teachers and students to suggestions and materials available on computers. For further details write to the Executive Secretary, NCTM, 1201 Sixteenth Street, N.W., Washington 6, D. C.

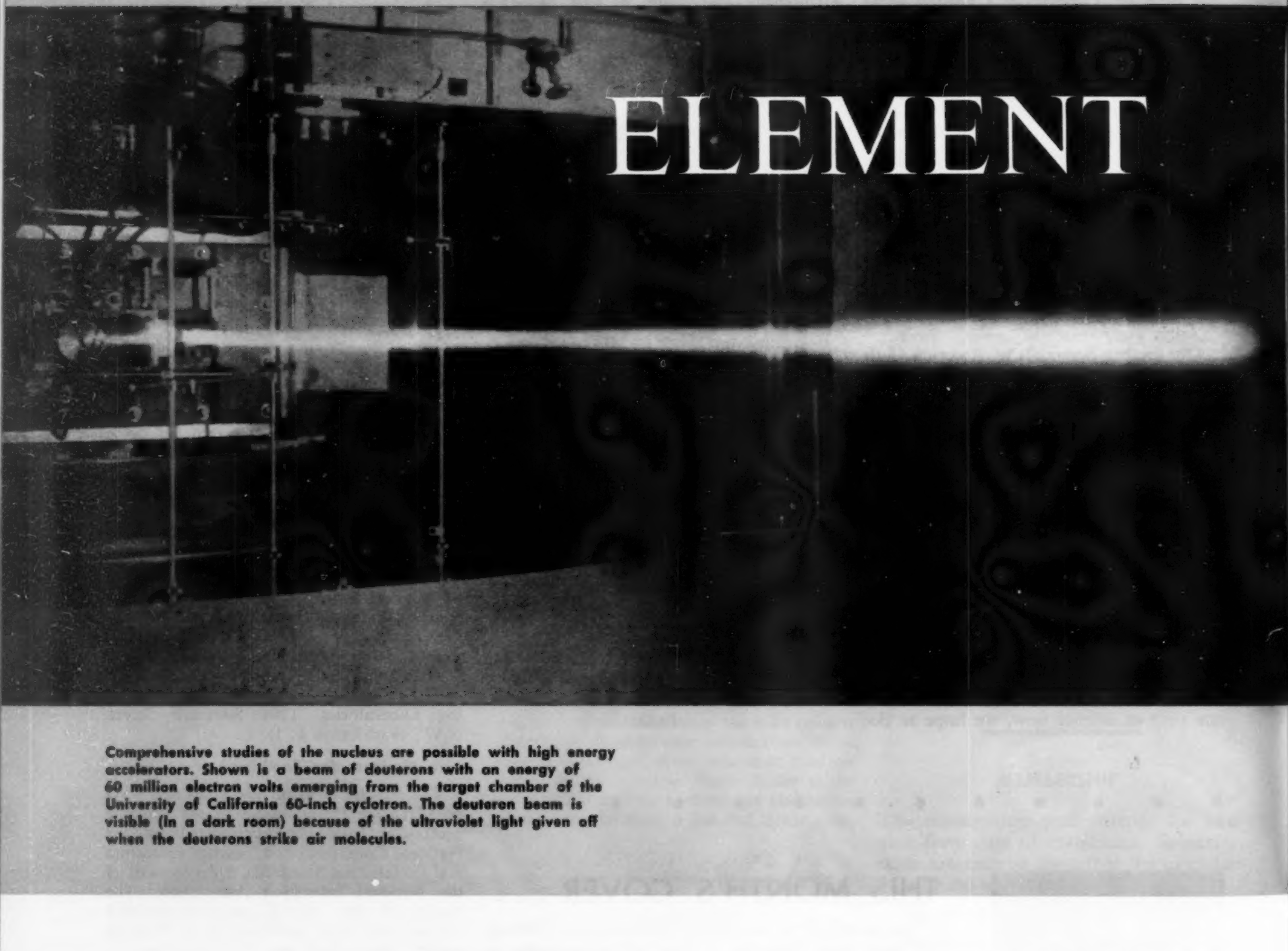
NTL Selected Readings Series

For a number of years the National Training Laboratories of the National Education Association have been active in bridging the gap between the social scientist and the practitioner who both attempt to apply scientific knowledge in solving day-to-day problems. One of the approaches is through the publication of a series of *Selected Readings* designed to bring together papers published since 1945 by various members of the NTL staff and some unpublished materials which show major concerns in human relations training. The first four books of the latest series are: Group Development, Leadership in Action, Human Forces in Teaching and Learning, and Forces in Community Development. $2 each. (Discounts on quantity orders.) National Training Laboratories, 1201 Sixteenth Street, N.W., Washington 6, D. C.

New Horizons for Teaching

The establishment of new goals and ways of advancing the standards of the teaching profession have been completed by the National Commission on Teacher Education and Professional Standards, a department of the National Education Association. The results of this special two-year national project have been published in a 256-page report, *New Horizons for the Teaching Profession*, which covers specific recommendations for selection, teacher education, accreditation, certification, and the advancement of professional standards. The study also provides a rationale for these recommendations and proposes action which might be taken toward complete professionalization of teaching. Copies may be ordered from NEA, 1201 Sixteenth Street, N.W., Washington 6, D. C. (Order by stock number.) Cloth $3 (No. 52-128); Paper $2 (No. 52-129).

DISCOVERY OF Lawrencium ELEMENT



Comprehensive studies of the nucleus are possible with high energy accelerators. Shown is a beam of deuterons with an energy of 60 million electron volts emerging from the target chamber of the University of California 60-inch cyclotron. The deuteron beam is visible (in a dark room) because of the ultraviolet light given off when the deuterons strike air molecules.

By ROBERT M. LATIMER

Chemist, Lawrence Radiation Laboratory, University of California, Berkeley, California

EARLIER this year a new element, *lawrencium* (Lw), was discovered at the Lawrence Radiation Laboratory in Berkeley, California. This now becomes the fifteenth "man-made" element. The discovery was made by nuclear chemists Albert Ghiorso (co-discoverer of eight other new elements), Torbjorn Sikkeland, Almon E. Larsh, and Robert M. Latimer.

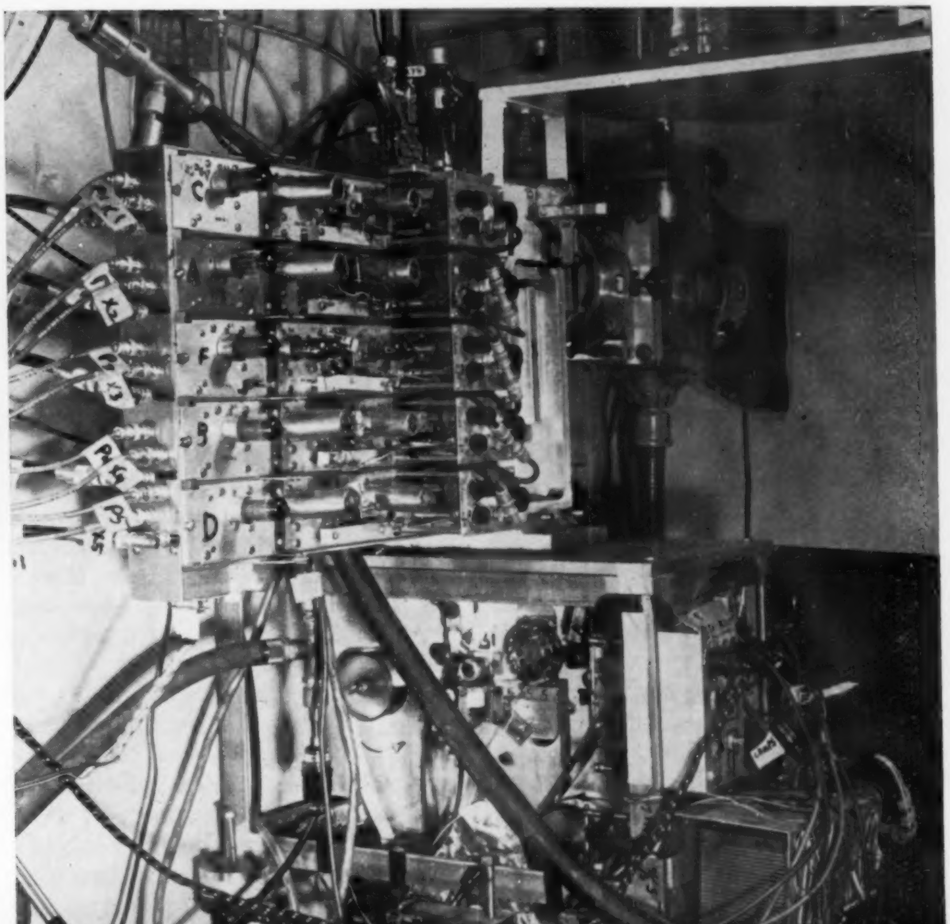
The modern Periodic Table of Elements (Figure 1) is somewhat changed from the fanciful chart used by the early alchemists and scientists for the elementary substances of nature (fire, water, air, etc.). Only nine elements were included in the references used by experimenters in the sixteenth century, but their work did make a contribu-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.0080																	2 He 4.003
3 Li 6.940	4 Be 9.013											5 B 10.82	6 C 12.011	7 N 14.008	8 O 16.000	9 F 19.00	10 Ne 20.183
11 Na 22.991	12 Mg 24.32											13 Al 26.98	14 Si 28.09	15 P 30.975	16 S 32.066	17 Cl 35.457	18 A 39.944
19 K 39.100	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.95	24 Cr 52.01	25 Mn 54.94	26 Fe 55.85	27 Co 58.94	28 Ni 58.71	29 Cu 63.54	30 Zn 65.38	31 Ga 69.72	32 Ge 72.60	33 As 74.91	34 Se 78.96	35 Br 79.916	36 Kr 83.80
37 Rb 85.48	38 Sr 87.63	39 Y 88.92	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc	44 Ru 101.1	45 Rh 102.91	46 Pd 106.4	47 Ag 107.880	48 Cd 112.41	49 In 114.82	50 Sn 118.70	51 Sb 121.76	52 Te 127.61	53 I 126.91	54 Xe 131.30
55 Cs 132.91	56 Ba 137.36	57-71 La Series	72 Hf 178.50	73 Ta 180.95	74 W 183.86	75 Re 186.22	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 197.0	80 Hg 200.61	81 Tl 204.39	82 Pb 207.21	83 Bi 208.99	84 Po	85 At	86 Rn
87 Fr	88 Ra 226.03	89-103 Ac Series	(104)	(105)	(106)	(107)	(108)										

Lanthanide Series	57 La 138.92	58 Ce 140.13	59 Pr 140.92	60 Nd 144.27	61 Pm	62 Sm 150.35	63 Eu 152.0	64 Gd 157.26	65 Tb 158.93	66 Dy 162.51	67 Ho 164.94	68 Er 167.27	69 Tm 168.94	70 Yb 173.04	71 Lu 174.99
Actinide Series	89 Ac 227.04	90 Th 232.05	91 Pa 231.05	92 U 238.04	93 Np 237.05	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 E	100 Fm	101 Mv	102 102	103 Lw

FIGURE 1. Periodic Table of the Elements. The synthetic elements are shaded.

View of the equipment used in the 103 experiment.



tion. These were carbon (C), sulfur (S), iron (Fe), copper (Cu), silver (Ag), tin (Sn), gold (Au), mercury (Hg), and lead (Pb). The beginning work of these men was with crude equipment, such as the retort and mortar and pestle. But however limited, through their interest in theory and experimentation, they were able to pin

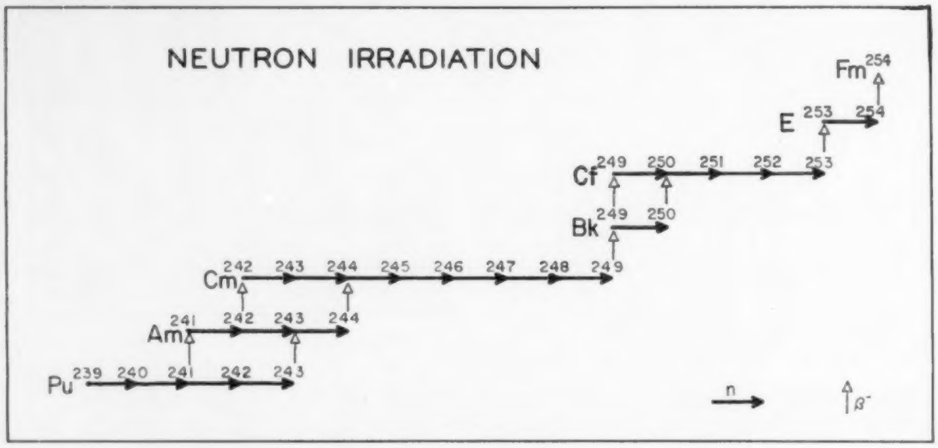


FIGURE 2. Production of heavy elements via slow neutron irradiation.

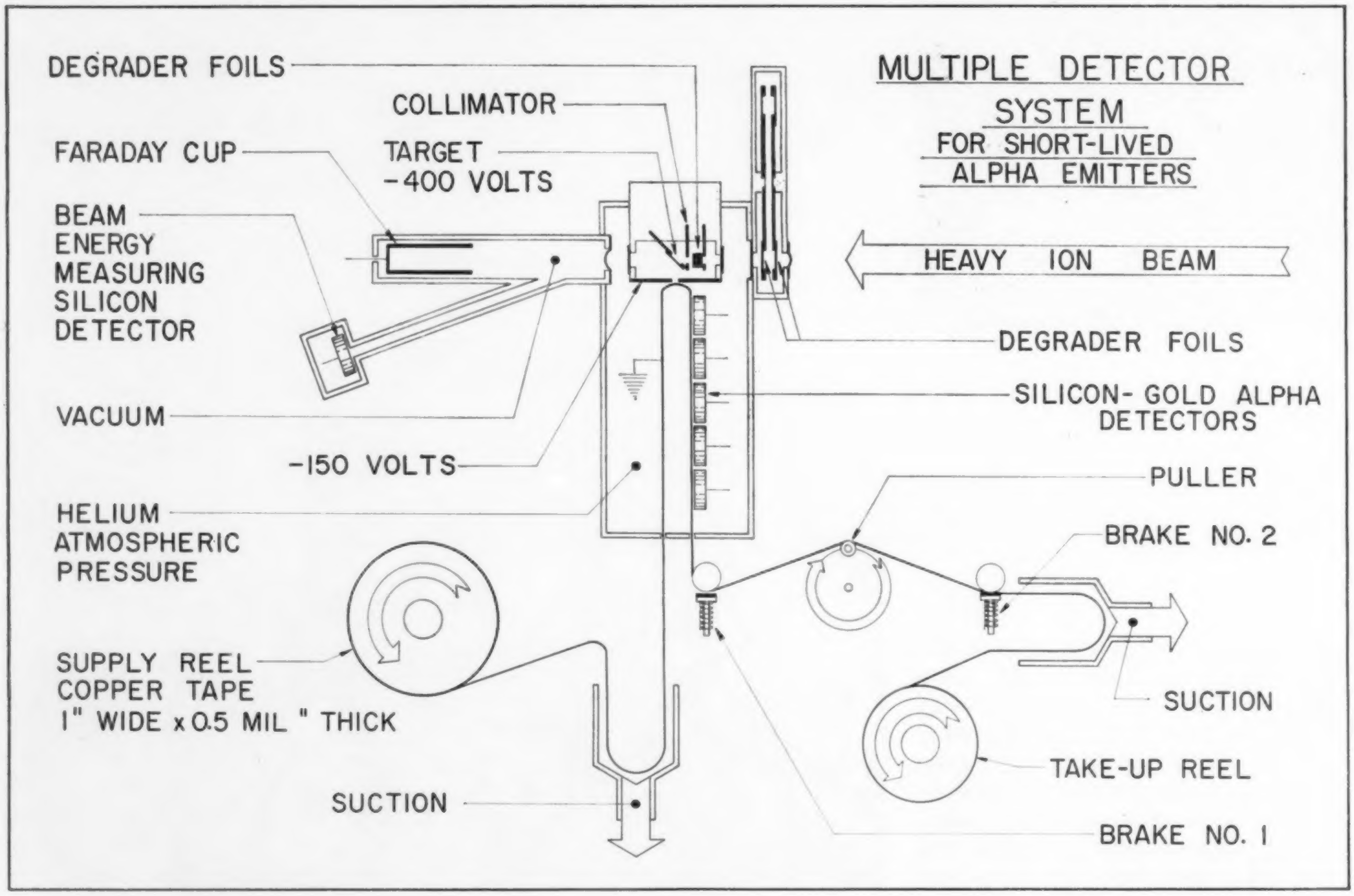
down some important elements known today. By the middle of the seventeenth century, thirteen elements were known, but none of the discoveries have been recorded in history.

Today, man has considerable equipment and methods with which to learn of the environment of the universe. Unlike early man who used simple tools to reshape natural materials, the present-day scientist relies on complicated machinery and equipment to perform the necessary chemistry of our day. In isolating tiny quantities of materials, it is necessary to use "hot" cave laboratories, cyclotrons, reactors, accelerators, and other complicated equipment. Accelerators are designed specifically for the purpose of producing heavy ions and are used by scientists to broaden their knowledge of the nature of atoms and atomic nuclei. The Berkeley accelerator (HILAC), used in the element-103 experiment, can bombard targets with particles as heavy as neon ions or even heavier ones.

The transuranium elements up to fermium (Fm) can be most easily prepared by neutron irradiation of plutonium (Pu) for several years in a high flux reactor (see Figure 2). Einsteinium (E) has been produced by neutron irradiation in barely weighable amounts. Above fermium the heavy isotopes decay just about as fast as they are made. Therefore, this method holds little promise currently for the production of elements as heavy as 103. Lawrencium decays with a half life of $8 + 2$ seconds and emits an alpha particle with an energy of 8.6 mev.

About ten years after the discovery of rhenium (Re) in 1925, it was theorized that any subsequent "new elements" should be radioactive and would

FIGURE 3. Schematic diagram of the equipment used in the 103 experiment.



The interior of a new type of atom-smasher or accelerator (the HILAC) constructed for an Atomic Energy Commission research program at the University of California Radiation Laboratory, Berkeley. Heavy fragments of matter are hurled through the doughnut-shaped "drift tubes" that extend the length of the atom "gun's" barrel. Man standing at the end of the big barrel (the post-stripper), gives idea of the size of the tank—90 feet long and 10 feet in diameter.

probably therefore have to be synthesized. Actually, some of the lighter synthetic elements do exist in nature in uranium ores—elements 43 and 61 as radioactive fission fragments, elements 85 and 87 as members of a rare decay chain, and at least two of the "transuranium elements" from neutron capture. All the transuranium elements, and perhaps some yet undiscovered elements, may have existed some four billion years ago when the earth was formed. But in the long time interval that has elapsed since the formation, it is expected that all have decayed away.

Charged-particle bombardment is the only path left open for the production of the very heaviest elements. To produce a new heavy nucleus out of two lighter nuclei, one must overcome the coulombic repulsion of the two atoms. For this purpose, the heavy-ion linear accelerator—HILAC—was built several years ago at the Lawrence Radiation Laboratory. The HILAC accelerates particles up to 10 mev per nucleon, that is, for instance 110-mev B^{11}. With this energy, it is possible to push two atoms together and create a new one.

In the 103 experiment, californium (Cf) was bombarded by boron ions. The californium had previously been produced by neutron irradiation. Three micrograms of californium, one-half the world's supply, was electroplated in an area 0.10 inch in diameter on a very thin nickel foil. The heavy-ion beam was collimated so as to pass only through the target material.

When a boron atom hits a californium atom, a new compound nucleus is formed which has a very excited state. This new nucleus then does one of two things to lose some of its extra energy. Most likely it breaks up or fissions, but a few of the new nuclei lose their extra energy by emitting neutrons, or neutrons and protons in some combination. This de-excitement or loss of energy takes place immediately (less than 10^{-12} sec) after the compound nucleus is formed.

The few atoms during a bombardment that de-excited themselves by losing particles recoiled from the target and stopped in a helium atmosphere. The new atoms were then carried with the helium gas out through a 0.050-inch orifice and electrically collected on a copper conveyor tape (see Figure 3). This tape was periodically pulled along a short distance in order to place the

successive groups of collected atoms in front of Au-Si (gold-silicon) solid-state detectors. Each time the tape was pulled, a new group of collected atoms was brought in front of the first of the five detectors, while the group that had been there moved to the second collector, and so on. The tape was pulled automatically every ten seconds, and about once in every hundred pulls or experiments the detectors would record the decay of an atom of 103. When the tape was pulled once every ten seconds, an activity with a 10-second half life produced twice as many counts in the first detector as in the second, the second twice as many as in the third, etc.

Au-Si solid-state detectors are a very recent development. Each one, with its volume of about a cubic inch, can replace a Frisch grid chamber with a volume of about one cubic foot. The detectors are solid-state ionization chambers. They are in many respects just half a transistor—a diode. When a charged particle—an alpha particle, for instance—passes into the detector, ion pairs are produced. These ion pairs are collected in the depletion region of the detector and an electrical pulse develops which is proportional to the energy of the charged particle. The pulse is then amplified and analyzed in a 100-channel pulse-height analyzer.

After californium (Cf) is bombarded by neutron irratiation, it is placed in the target holder illustrated.

Before the experiments started, it was predicted that 103 would have a half life somewhere between 0.3 and 30 seconds and have an alpha-decay energy in the range of 8.0 mev to 8.8 mev. With everything working correctly, up to five counts an hour might be detected during the operation.

In the experiments, counts from decaying 103 atoms were not, unfortunately, the only counts expected. Tracer amounts of lead and bismuth also produce, when bombarded with boron atoms, alpha activity of 8.1 and 8.8 mev. Early experiments showed that this activity could completely mask any activity produced from the californium, unless the amounts of lead and bismuth were reduced to a very low level. The target material was finally purified by heating californium in a vacuum and boiling out the lead and bismuth. It was impossible to separate out the impurities chemically, as even the best reagents available contain too much lead and bismuth. After the "pure" target had been bombarded for many hours, the 8.6-mev activity began to stand out. Many more hours of bombardment were needed to determine that its half life was about 8 seconds. When these two feats had been accomplished, many different targets such as curium (Cm), americium (Am), lead (Pb), and bismuth (Bi) were bombarded under exactly the same conditions to show that they would not produce the activity. During a two-month period, about 100 countable atoms of lawrencium were produced.

Although *lawrencium* has not been chemically isolated, the experiments conclusively showed that it is a new element. Chemically, it will exhibit the properties of an actinide element. The last *5f* electron is filled in lawrencium, thus making it the last of the actinide series. In the future, when increased amounts of lawrencium are produced, its chemical and physical properties can be further studied.

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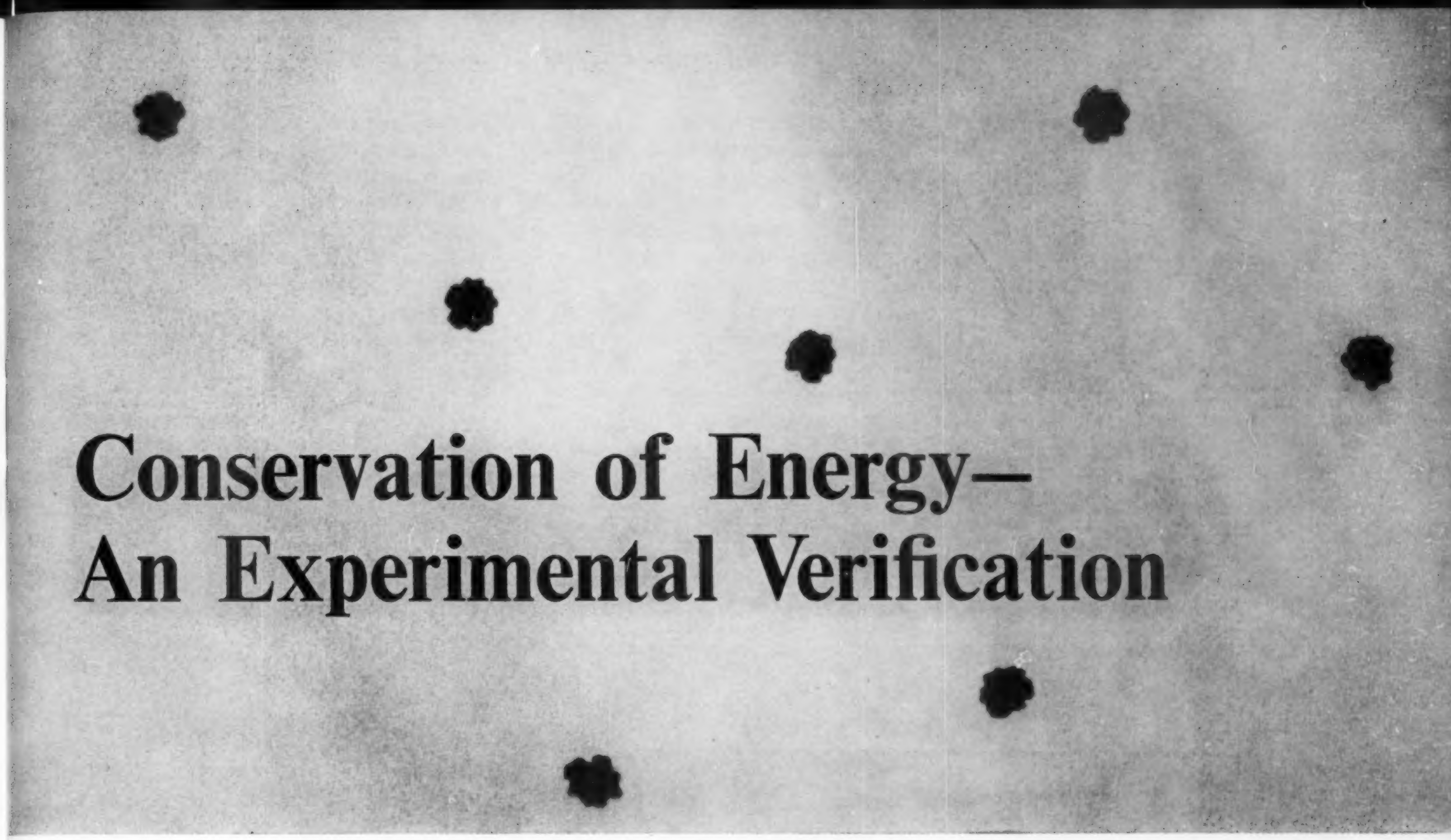


Conservation of Energy— An Experimental Verification

By FRED T. PREGGER

Professor of Science, Trenton State College, Trenton, New Jersey

ALL beginning physics courses emphasize strongly the principle of conservation of energy, and in fact use this principle as a tool in the understanding of many subsequent topics. Yet, this principle is seldom illustrated by a quantitative demonstration or laboratory experiment. The reason commonly given for this omission is that most energy systems are not conservative so that frictional and other energy losses preclude the quantitative verification of the principle. Experiments on efficiencies of machines and mechanical equivalent of heat do make use of the principle, but in each case the validity is tacitly assumed and results are compared to it as a standard.

The Problem

A simple quantitative demonstration of the principle is available at least in a restricted sense, the conversion of gravitational potential energy to kinetic energy in the case of a falling body. Consider the standard problem, "Show that when a body of mass *m* is dropped from a height *h*, the sum of its kinetic and potential energies at any instant is constant and equals *mgh*."[1] This can be easily proven mathematically but when it comes to illustrating it experimentally, the problem of being able to measure simultaneously the positions and corresponding instantaneous velocities of the body must be solved. If this can be done, then the potential energy of the body can be measured before it starts to fall, and the sum of the potential and kinetic energies at various positions in its path can be computed and shown to be equal to the initial potential energy. If the falling body is fairly heavy and the fall is in the order of a few meters so that air resistance is a negligible factor, the results obtained are very convincing.

The Method

The basic equation is:

$$mgh_t = mgh_1 + \tfrac{1}{2} mv_1^2 = mgh_2 + \tfrac{1}{2} mv_2^2 = mgh_3 + \tfrac{1}{2} mv_3^2, \text{ etc.},$$

where the subscripts refer to arbitrary positions in the path of the falling object that is used.

A Behr free-fall apparatus using a plummet and a timed spark through waxed paper, a falling fork apparatus using a freely falling vibrating tuning fork that traces an undulated line on smoked glass, or a Physical Science Study Committee (PSSC) free-fall apparatus using a paper strip and a door bell clapper may be used for the experiment. This paper will give the results obtained from the Behr electrical apparatus, but the technique can be easily applied to the other types.

The data needed are:

1. *Mass of the falling object.* A study of the equations shows that the mass is irrelevant to the results of the experiment. However, in order to utilize energy units, to let the student see that we are dealing with joules, ergs, or foot pounds, it is valuable to measure the mass.
2. *Positions of the falling object and instantaneous velocities at these positions.*

[1] R. L. Weber, M. W. White, and K. V. Manning. *College Physics*. Third Edition. McGraw-Hill Book Company, New York. 1959. p. 77.

3. *The value of* g, *the acceleration due to gravity*. The mass of the object can be measured with a beam balance.

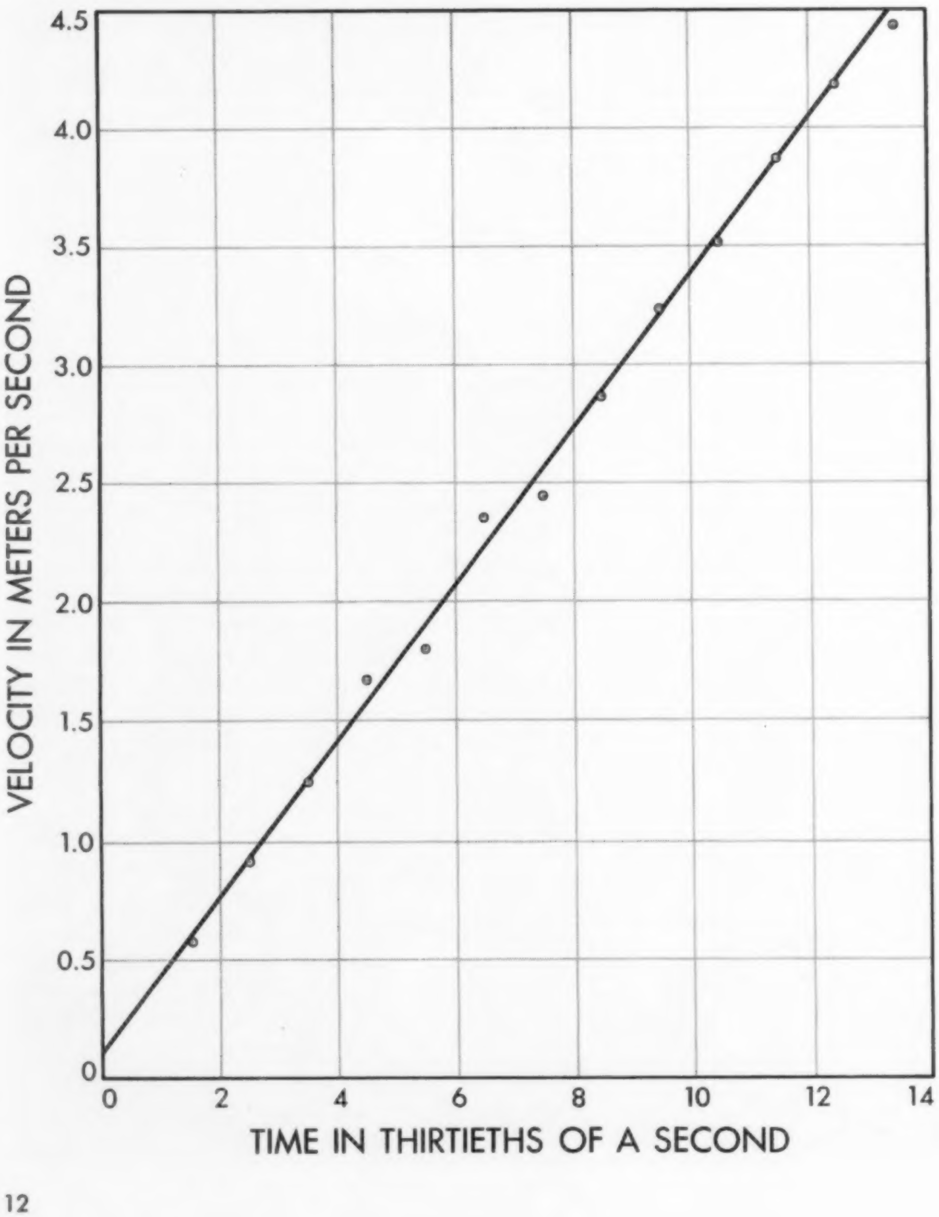
The value of g can be obtained from a handbook, or an enterprising class might choose to determine g from the data of the experiment.

The positions of the falling body can be determined at known instants of time by measuring the holes punched in the waxed paper tape by the timed electric spark. The bottom point may be arbitrarily chosen as the zero potential energy reference level, and all points measured upward from it. The top position of the object must be measured very carefully in this part before it starts to fall.

For class demonstration, it is instructive to leave the tape on the machine to give the students a continual physical picture of what is happening. For laboratory purposes and greater accuracy in measuring, the tape may be taken off the machine and measured by individuals or small groups at the laboratory tables. Two meter sticks are very useful here. It is important to measure the positions of the spark punctures to the nearest tenth of a millimeter in order to calculate average velocities and get a good velocity-time curve.

The easiest way to determine instantaneous velocities at the positions marked by the spark punctures is to plot a curve of velocity of the plummet versus time of fall, and read from the curve the velocities occurring at the desired instants, and therefore at the positions occupied by the plummet as the spark punctures were made. The point to remember here is that each spark puncture represents both the position of the plummet at known instants of time, and the time itself. In the plotting of data and in making calculations we use the spark punctures to represent both of these concepts.

FIGURE 1. Velocity of plummet versus time of fall.



If the time interval of the spark device is known, then the elapsed time between successive spark punctures is known. The distance travelled between successive spark punctures can be measured. Then by use of

$$v = \frac{s}{t},$$

where s is the distance from one hole to the next, and t is the time interval between one spark and the next, the *average velocity* over each time interval can be computed. The graph of average velocity versus time is drawn. Since the motion is uniformly accelerated, velocity varies directly with time and the resulting curve will be linear. (See Figure 1.) The average velocities calculated will occur at the *middles of the corresponding time intervals* and must be plotted this way. Then the graph can be used to measure the *instantaneous velocity* at each position marked by the spark punctures by simply reading the value of v at the instant of time corresponding to each spark puncture.

Any spark puncture can be taken at random. The position of the plummet above the zero reference level can be measured and its potential energy computed by $E_p = mgh$. The velocity at that point can be determined from the graph and the kinetic energy computed by $E_k = \frac{1}{2} mv^2$. When these are added it will be found that the sum is equal (within the limits of experimental error) to the potential energy of the plummet at its highest point. These calculations have been carried out for each position in one run of the experiment and are shown in Table I.

For instance, consider spark puncture 8 in the set of data given. At the position marked by the eighth spark puncture below the top of the path, the plummet was 0.7361 meters above the bottom. Therefore it had potential energy ($mgh = 0.512 \text{ kg} \times 9.80 \text{ m/sec}^2 \times 0.7361 \text{ m}$) of 3.70 joules. At this position the plummet was in motion and therefore it possessed kinetic energy. The velocity-time curve shows

that at this position the velocity was 2.71 meters per second. The equation $E_k = \frac{1}{2}mv^2$ gives kinetic energy of $\frac{1}{2} \times 0.512 \text{ kg} \times (2.71 \text{ m/sec})^2$ or 1.90 joules. The sum of the potential energy and the kinetic energy at this position was 5.58 joules which is in good agreement with the 5.59 joules of potential energy that the plummet had at its topmost point.

Plotting Results

The results of the experiment can be summarized graphically by plotting on the same set of axes the kinetic energy at each position, the potential energy at each position, and the sum of the potential energy and kinetic energy at each position. Figure 2 shows this relationship. It is apparent that energy is conserved.

This experiment is useful to the student for several reasons:

1. It gives a simple convincing experimental verification of the principle of conservation of energy. The method is direct and elementary enough so that a good student or a class with guidance by the teacher can devise it and carry it out to conclusion.
2. It gives practice in using data to plot a curve and then to make use of the curve to obtain further information.
3. It is open-ended. It can lead to studies of the effects of air resistance on a lighter plummet, methods for finding instantaneous velocities without using the curve, the application of the same technique to an object on an inclined plane and the effects of friction and/or rotational inertia in the case of the object on the inclined plane.
4. Following the experimental study, one can prove the problem stated in the introduction by means of the usual algebraic argument.

Experiment

A sample laboratory experiment is included as Appendix A. This experiment is used with our course in Introduction to Physics, a one-semester physics course given for general education purposes to nonscience majors at Trenton State College. However, based on my experience in teaching high school physics, I would not hesitate to give this experiment to a high school physics class. The teacher could prepare additional instruction, if needed.

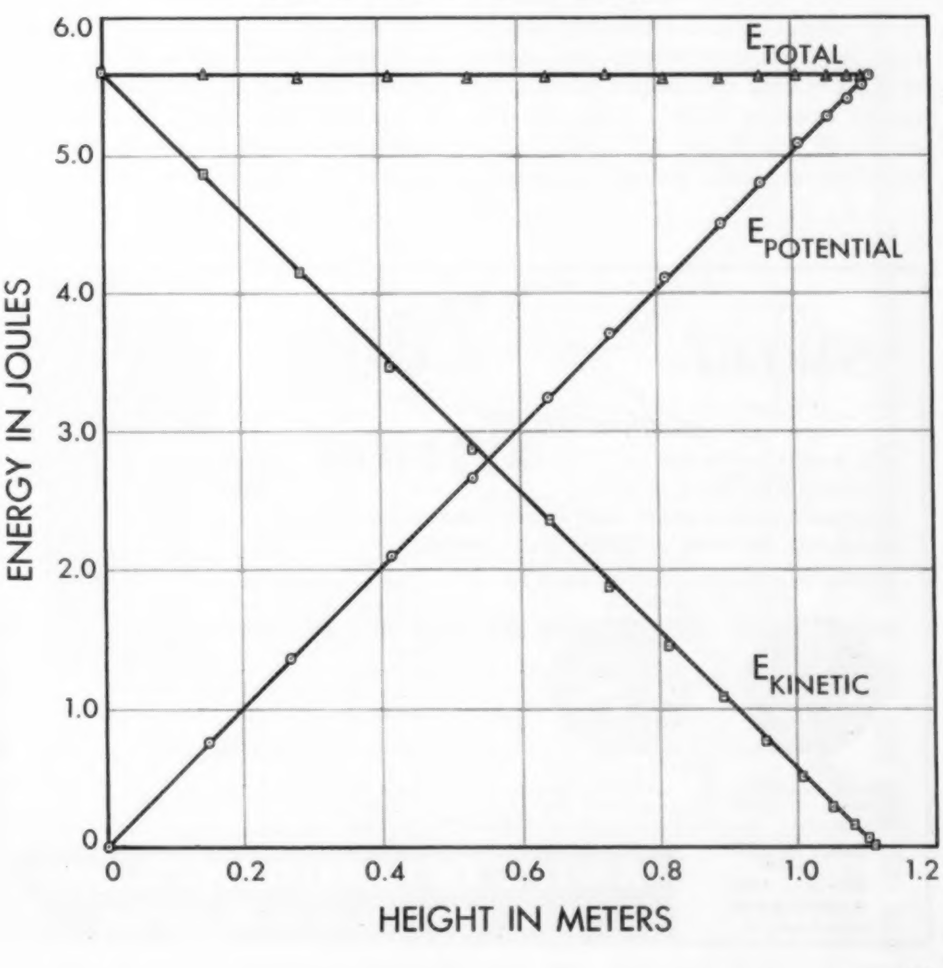
TABLE I. EXPERIMENTAL DATA

Mass of Plummet (m) — 0.512 kg
Acceleration Due to Gravity (g) — 9.80 m/sec^2
Period of Timer — 1/30.0 second

Time (sec/30)	*Height (meters)*	*Average Velocity ($m/\frac{1}{30}sec$)*	*Average Velocity (m/sec)*	*Instants of Velocity (m/sec)*	*Potential Energy (joules)*	*Kinetic Energy (joules)*	*Total Energy (joules)*
t_0 0	h_t 1.1120			0.00	5.59	0.00	5.59
*t_1 1	h_{13} 1.1020			0.42	5.54	0.05	5.59
t_2 2	h_{12} 1.0828	0.0192	0.576	0.75	5.44	0.14	5.58
t_3 3	h_{11} 1.0524	0.0304	0.912	1.07	5.28	0.29	5.57
t_4 4	h_{10} 1.0110	0.0414	1.242	1.40	5.08	0.50	5.58
t_5 5	h_9 0.9554	0.0556	1.668	1.72	4.80	0.76	5.56
t_6 6	h_8 0.8956	0.0598	1.794	2.05	4.50	1.07	5.57
t_7 7	h_7 0.8173	0.0783	2.35	2.38	4.10	1.45	5.55
t_8 8	h_6 0.7361	0.0812	2.44	2.71	3.70	1.88	5.58
t_9 9	h_5 0.6407	0.0954	2.86	3.03	3.22	2.35	5.57
t_{10} 10	h_4 0.5330	0.1077	3.23	3.36	2.68	2.89	5.57
t_{11} 11	h_3 0.4160	0.1170	3.51	3.69	2.09	3.48	5.57
t_{12} 12	h_2 0.2871	0.1289	3.87	4.02	1.44	4.12	5.56
t_{13} 13	h_1 0.1478	0.1393	4.18	4.35	0.74	4.84	5.58
t_{14} 14	h_0 0.0000	0.1478	4.43	4.68	0.00	5.60	5.60

* Since the plummet probably did not begin to fall at the instant a spark hole was punched, the time from t_0 to t_1 probably does not represent 1/30 second, and the distance h_t-h_{13} probably is not the distance which the plummet fell in 1/30 second. Therefore, the average velocity is not computed for this interval of time and distance. However when the curve is plotted and extrapolated based on the other time intervals, the instantaneous velocity at h_{13} can still be determined.

FIGURE 2. Energy as a function of height.



My thanks is expressed to Judson Fink and Herbert Moses of Trenton State College, Trenton, New Jersey, for their helpful suggestions in writing the direction sheet for the experiment, and to Frank Sutman and Frank Harmon of the State University of New York College for Teachers at Buffalo, New York, for testing the experiment and offering the suggestion to plot the E_k, E_p, and E_t curves.

APPENDIX A

Laboratory Directions for Experiment on Conservation of Energy

Object: To illustrate the principle of conservation of energy in a gravitational field.

Method: We can give potential energy to an object by lifting it. The amount of energy gained by the object is equal to the amount of work done in raising the object from some arbitrary zero reference level to a height *h*. In equation form this is:

$$W = Fs = wh = mgh.$$

If we let the object fall freely back to the zero level, we change the position of the object without extracting energy from it (while it is falling). An object of mass *m* with a velocity *v* has kinetic energy equal to $\frac{1}{2}mv^2$. When the object is at rest it has no velocity and therefore no kinetic energy. As the object falls its kinetic energy increases due to the fact that its velocity continuously increases. (A falling object undergoes uniform accelerated motion.) At the same time the potential energy of the object decreases due to the decrease in height. We are looking for the relationship between (1) the potential and kinetic energies at any point in the path, and (2) the potential energy which the object had at its maximum height before it started to fall.

We can find this relationship by the use of the Behr free-fall apparatus. The technique is to allow the plummet to fall while the timed spark is operating. As in the experiment on acceleration, the spark punctures indicate the position of the plummet at various instants of time, and we must determine the instantaneous velocity of the plummet at each spark puncture.

Measure the position of the plummet at its maximum height by scraping the V-shaped collar against the waxed paper tape. Operate the apparatus and get a record of the positions of the plummet as it falls. Choose the bottommost spark puncture as the arbitrary zero level. Determine the potential energy of the plummet at each spark puncture. Since kinetic energy is equal to $\frac{1}{2}mv^2$, it follows that *v*, the instantaneous velocity of the plummet must be found at each spark puncture. The easiest method of measuring this is by plotting a velocity-time curve using average velocities during each time interval plotted against time at the middle of each interval. (See experiment on Uniform Accelerated Motion.) The instantaneous velocity at each position recorded by the spark punctures can be read directly from this curve.

Using the data obtained, find the relationship that exists between (1) the potential energy of the plummet at its highest point, and (2) the kinetic and potential energies of the plummet at any arbitrarily chosen point in its downward path.

Graphs:

Plot the following curves on the same set of axes:

(a) Potential energy against height above the arbitrary zero level for each spark puncture.
(b) Kinetic energy against height above the arbitrary zero level for each spark puncture.
(c) Total energy against height above the arbitrary zero level for each spark puncture.

Questions:

1. In this experiment friction is a negligible factor. What would the results of the experiment be if there were an appreciable amount of friction in the apparatus? How could the experiment be modified to include a significant amount of friction?

2. Why is the topmost position of the plummet measured by the position of the V-shaped collar rather than some other point on the plummet?

3. The experiment can be performed in the same manner without measuring the mass of the plummet. Show why this is permissible. Why does your instructor ask you to use the mass in your calculations? (What advantage is there to you as a beginning student of physics to keep the mass in the calculation; what concept is involved that might not be clearly seen if the mass is not used?)

4. What happens to the energy in the plummet when it comes to rest in the receptacle at the bottom of the apparatus?

5. See if you can derive a general equation which will state the experimental facts investigated in this experiment. (Hint: Let the maximum potential energy at height h_t be mgh_t.) Then find expressions for potential and kinetic energies at any other height.

Sixty
SPENCER

Why Are Elementary School Teachers Reluctant to Teach Science?

By EDWARD VICTOR

Associate Professor, Northwestern University, Evanston, Illinois

EXCITING and significant developments in science education are taking place throughout the country. One of these developments is the establishment of definite, integrated science programs in the elementary school, as part of over-all, continuous K-12 science programs.

Over a period of years the teaching of science in the elementary school has already been growing, gradually but steadily. The current boom in science education however has hastened this growth tremendously, transforming it from a gradual growth to an urgent one.

Everywhere elementary school teachers are being asked to either add science or give more time to science in their daily programs. Superintendents are calling upon principals and supervisors to give special attention to increasing both the *quality* and *quantity* of science being taught by the elementary teachers. Workshops and institutes are being held to develop or improve curriculum guides and courses of study.

Concurrent with this increased activity in elementary science is the increased awareness of a condition which threatens to become a key problem or stumbling block in the successful operation of an elementary science program. This condition refers to the reluctance of so many teachers in our schools to teach science.

The Problem

This reluctance is nothing new. The literature has acknowledged its existence for some time. With the present emphasis upon science in the elementary school, however, such reluctance gains added significance. No science program, no matter how well developed, can operate successfully if the teachers are reluctant to teach science. The motivation of the children, and the quality and quantity of their science learning experiences, cannot help but suffer as a consequence.

The most common reason offered for this reluctance to teach science is the inadequate science background of the elementary teachers. This reason seems to be so logical and so widely accepted, that comparatively little research has been done to confirm it as a definite and valid factor.

Other reasons have also been offered. Little has been done though to determine whether these reasons are independent factors in themselves, or whether they have developed either as logical consequences of an inadequate science background, or as substitutes for an understandable reluctance to admit to an inadequate preparation in a teaching field.

Consequently, it seemed appropriate at this time to conduct a study of such factors which might be involved in the reluctance of elementary teachers to teach science. Possible factors selected for investigation included:

1. Lack of familiarity with the subject and materials (inadequate science background).
2. The feeling that one has to be a science expert to teach science in the elementary school.
3. Lack of familiarity with objectives of science education in the elementary school.

4. The feeling that science teaching is a man's job.
5. The feeling of loss of classroom prestige, due to difficulty in answering questions about or teaching various phases of science.

The Study

A questionnaire was designed to ascertain attitudes and opinions about the factors listed above, together with other pertinent information. It was considered advisable to obtain questionnaire responses from all the teachers in one elementary school system. Since a sample of at least 100 teachers was desired, a city in the state of Illinois with a population of approximately 25,000 was randomly selected. This city employed 117 teachers in elementary grades one through six.

All 117 elementary school teachers were given copies of the questionnaire, 106 of which were completed, giving a 90.6 per cent return.

The questions calling for attitudes or opinions were usually asked three different ways in an effort to achieve greater validity of response. In looking for significant correlations, the three responses were converted to scales wherever possible. Thus, a teacher giving the same kind of response to all three questions was assigned a score of 3. A teacher giving the same kind of response to two of the three questions was assigned a score of 2, etc.

Tests for significance included the z-test, chi-square, coefficient of correlation, and the t-test. All of the responses were significant beyond the 0.01 level of confidence.

Of the 106 teachers that answered the questionnaire, 98 or 92.5 per cent were women, and only 8 or 7.5 per cent were male.

Most of the persons were experienced teachers. Approximately 80 per cent had taught for four or more years, and 65 per cent for ten or more years.

Although most of the teachers had taken one or more science courses, other than general science, in high school, there were 11 teachers who had taken none. Of the courses taken, biology was the most common one, followed by physics, then chemistry.

Approximately 75 per cent of the teachers had taken less than two years of science in college, with biology the most common course, followed by chemistry, physics, geology, and astronomy, in that order. Sixty-three, or 59 per cent, of the teachers had not taken a methods course in the teaching of elementary science.

The teachers devoted 2 to 5 days per week to teaching science, with a mean of approximately 3½ days. They spent 1 to 3 hours a week teaching science, with a mean of 1.75 hours.

Although they reported an adequate supply of science equipment, reference material, and filmstrips, the teachers conducted experiments infrequently in the classroom. In fact, 89 per cent of the teachers used experiments in the classroom once a week or less, and 42 per cent did experiments once a month or less. For the latter, this implied that experiments were performed in class not more than 9 to 10 times during the school year. Almost half of the teachers reported that other activities (usually classroom activities) cut into or interferred with the time alloted to teaching science.

The teachers thought that chemistry was most difficult for an elementary teacher to teach, followed by physics, astronomy, and geology, in that order. However, in almost direct contrast, they felt that a course in biology would be most helpful to the teacher, followed by geology, chemistry, physics, and astronomy, in that order. This rank order of helpfulness of courses coincided closely with the list of science courses most commonly taken in college. This might seem to indicate that when teachers recognize the need for more science background, they would rather begin by going deeper into an area with which they are familiar—such as biology—rather than undertake the study of something new and unfamiliar, like chemistry, physics, or astronomy.

The teachers seemed to be unfamiliar with the objectives of science education, being more inclined to teach for, or stress, the technological aspects of science rather than the underlying principles and philosophy. Seventy-two per cent of the teachers thought it was more important for children to learn the practical applications of science than to learn the underlying scientific principles, and 80 per cent thought it was more important for children to learn science content than to learn to think critically.

This almost exclusively female group of teachers almost unanimously

agreed that males were better suited to teach science than females. The small group of eight male teachers, of course, agreed wholeheartedly with the female teachers.

It could very well be that there is a relationship between the reason for this response and the fact that the teachers were inclined to teach technology rather than the underlying scientific principles. The relationship may appear to be rather farfetched at first, but steadily grows more plausible with contemplation. We know that technology is often associated with gadgetry. Gadgetry is associated with "do-it-yourself," and "do-it-yourself" is associated with the male sex. Consequently, the females would logically tend to think that the teaching of science was a male domain. If this feeling is general among our elementary school teachers, who are predominantly female, then it would be a definite factor in their reluctance to teach science.

Almost half of the teachers felt that a person had to be a science expert in order to teach science in the elementary school. They also felt that this would be a definite factor in the reluctance of elementary teachers to teach science.

The statement is quite commonly made, and accepted, that science in the elementary school should be kept simple. If this statement is valid, then one could assume that a *thorough* knowledge of the contents of a good junior high school series would be sufficient for an elementary school teacher to do at least an adequate job of teaching science. Yet 77 per cent of the teachers thought that this amount of knowledge was not sufficient to do an adequate job. And 40 per cent did not think that even the thorough knowledge of the contents of a high school biology, chemistry, and physics textbook was sufficient science background to teach elementary science adequately.

Unfamiliarity with science content and materials (an inadequate science background) was considered to be a definite factor in the reluctance of the elementary school teacher to teach science. This was the opinion of 76 per cent of the teachers.

Loss of classroom prestige—probably a logical consequence of an inadequate science background—was also considered to be a contributing factor to this reluctance. Sixty-six per cent of the teachers agreed that this reluctance was due to the fact that the teacher often found it difficult to answer some of the questions raised by pupils highly interested in science. Sixty-four per cent agreed that the reluctance was engendered because the teacher was often disconcerted by pupils' questions about a phase in science with which the teacher was unfamiliar. Sixty-one per cent agree that reluctance developed because the teacher was often placed in the position of having to say "I don't know," when asked about a phase of science with which the teacher was unfamiliar.

Tests were made for relationships with each other of the responses or scale scores for the questionnaire items. Significant relationships were found only with respect to the collegiate science background and the sex of the teachers.

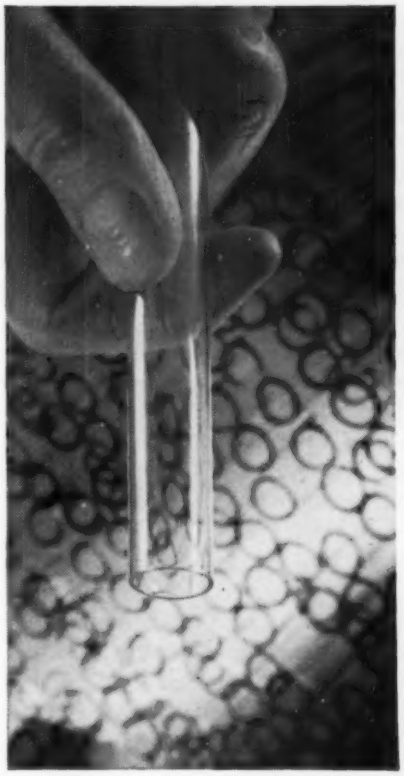
Those teachers who had a greater background in college science devoted more time to teaching science, used demonstrations and experiments more often, and felt more strongly that the reluctance to teach science was due to lack of familiarity with the subject and materials.

The male teachers were more familiar with science objectives, felt more strongly that science teaching was a man's job, and that the reluctance to teach science was due to lack of familiarity with the subject and materials.

These significant relationships involved the use of the coefficient of correlation and the t-test. They were all significant beyond the 0.01 level of confidence.

Conclusions

Although an inadequate science background is definitely a factor in the reluctance of elementary teachers to teach science, other factors also exist. These other factors seem for the most part to have developed either as logical consequences of an inadequate science background or as substitutes for an understandable reluctance to admit to an inadequate preparation in science. The fact remains, however, that these factors and attitudes do exist, and strongly so. As such they must be taken into consideration in any program, preservice or in-service, designed to overcome this reluctance to teach elementary science in the classrooms.



CREATIVE RESEARCH with PLANARIA

By LOUIS PANUSH

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NEVER had I seen so many fascinating worms (or "beasties" as they are called affectionately by the experimenters) in one place, or so much attention being given to these "lowly" creatures, as I did last February in the laboratory of the Planaria Research Group in the Psychology Department of the University of Michigan at Ann Arbor: Worms in glass "planariums," (a planaria aquarium) in V-shaped troughs, semi-circular troughs, glass jars, and in individual finger bowls; worms gliding on the surface of the water, crawling on the sides and bottom of the trough, turning right or left, contracting, curling up in a ball, or disdainful of the surrounding—experimenters and visitors included; worms being handled with tender and loving care, or squirted with water, stimulated by light, shocked with electric current, cut, grafted, regenerated, or irradiated. These activities were a part of the ongoing and continuing investigations[1] of learning and memory in planaria.

Planaria have been classic material for studies in regeneration and in sensitivity to light, touch, and chemicals since the early part of this century. However, only in the last five to eight years did planaria research become a favorite subject in investigations on learning and memory, because they were the "lowest animals on the phylogenetic scale to possess a true synaptic-type nervous system and the powers of complete regeneration" (1).*

In 1955, two graduate students in psychology at the University of Texas, James V. McConnell and Robert Thompson, undertook to discover whether this lowly flatworm could learn. They used a simple classical conditioning situation: an electric shock, which always made the worms contract (the unconditioned stimulus—UCS), was preceded by two seconds of light (the conditioned reflex—CS), which originally caused no gross movements in the animals. After 150 or more trials the experimental animals began responding to the light alone, significantly more times than did the control animals, before the shock came on by body turning and contracting or by head lifting and turning. The experimenters felt that they had demonstrated conditioning, a basic form of learning, in the planarian (4).

The work was not pursued further until McConnell came to the University of Michigan a few years later. There the Planaria Research Group was organized, consisting of graduate and undergraduate students, with James V. McConnell as director of the project and Margaret L. Clay as coordinator of the laboratory. A laboratory was established in the basement of the psychology department and serious research on learning and memory in flatworms began.

One of the first studies undertaken was to investigate the retention of the conditioning in regenerated animals in an attempt to find the "locus of learning" in the flatworms. After a conditioning procedure similar to the one described above, but much more refined and perfected,** and having a conditioned response (a longitudinal

[1] Arthur Koestler. "Michigan Crawlers Are Crossing Up Mendel." *The Washington Post*, October 1, 1961. p. E4.

* See references.

** It took a long time and much painful effort to learn how to house, feed, and care for the planaria, produce the right kind of apparatus, and develop the best procedure (run) to condition them.

contraction of the body) well established, the animals were cut in half and then allowed to regenerate completely. Following a method developed by the experimenters, it was found that "both the head and tail sections showed equal and highly significant retention of the conditioned response" (1), (3).

In another study by the group, the worms were cut (behind the pharynx) and only the heads were conditioned; the tail sections were discarded. The heads were then allowed to regenerate completely, *i.e.,* to grow new tails. The new animals (labelled "second generation") were again cut and each half was allowed to regenerate into a complete worm ("third generation"). It was found that both the heads and tails of the "third generation," as compared with the original training of the control subjects, or with the heads of the "first generation," exhibited significant "savings" of the original conditioned response (2).

The results of these and other investigations led the experimenters to theorize that the "learning which takes place in planaria is related to a chemical change in the nervous system. The chemicals facilitate learning as well as act as organizers determining the development of regenerating nerve cells" (1).

These experiments opened up a whole new series of questions which the group at Michigan, as well as others at various universities in the country, have been trying to answer.

The Michigan laboratory is currently engaged in the following lines of planaria research: (a) Investigation of the retention of the response in both regenerated portions and in sexually reproduced offspring of conditioned animals; (b) Investigation of the effects of radiation on both regeneration and acquisition and retention of the conditioned response (Project "Glowworm"); and (c) An effort to pin down anatomically the neural and regenerative apparatus in planaria, in order to understand better how the things which do occur can occur and to determine how far the researcher may generalize the information gathered for application to other more complex animal forms.

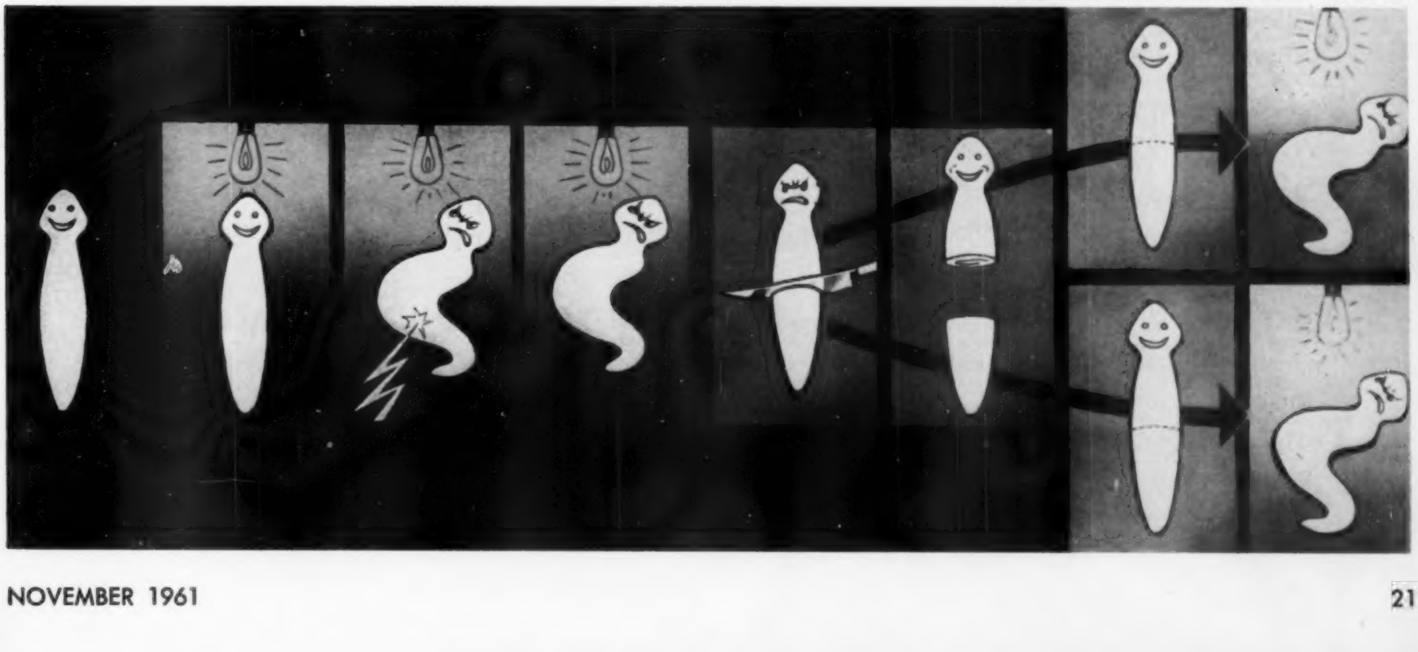
The group is also working on another interesting subject; namely, the effect of grafting and cannibalization on conditioning and the transfer of learning. Grafting is not an easy feat to accomplish; grafts do not "take" and a lot of work is being done on that problem—first, to graft parts of conditioned worms (the head) onto naive worms (the tail) and then finding out if learning transfer occurs. And, since the group discovered that these animals will cannibalize under the proper conditions, conditioned worms are being fed to naive, hungry ones in order to find out if there is some type of "digestive transfer of conditioning."

Interest in planaria research is running high not only in university laboratories but also in many high schools across the country. (Among some of the formal investigation either ongoing or completed are the retention of T-maze learning in "second generation" planaria, the effects of RNA-ase on the retention of the conditioned response in regenerated flatworms, the locus of retention, and retention in two-headed planaria.) It is remarkable how this type of research captured the imagination of the inquisitive minds of high school students and became a favorite subject of research especially in terms of biology projects for science fairs. In one high school (Penfield, New York), research was conducted by a group of fifty-five students and coordinated with the experimental work at Michigan.

Biology teachers who are looking for ways to interest their students in doing creative research in this field will get encouragement *and* information from the Planaria Research Group at Michigan. Their publication, *The Worm Runner's Digest,* (5) carries specific information on the experimental apparatus and the running procedure to be used (one will profit from their hard-won experience on how *not* to run worms), on the feeding and care of the animals, ongoing and completed studies as reported by the experimenters themselves, results obtained and difficulties encountered, and a general "philosophy" of a "worm runner" which will give one a needed perspective and sense of humor to *enjoy* the serious side of the worthwhile scientific endeavor. Inquisitive students

Flatworms are being used by University of Michigan researchers to document and analyze how certain types of learning may be inherited. The drawing shows how a flatworm taught that light is uncomfortable can become two flatworms with the same response when cut in half.

UNIVERSITY OF MICHIGAN NEWS SERVICE, ANN ARBOR, MICH.



will be stimulated not only to examine results, but to ask new questions and search for new knowledge.

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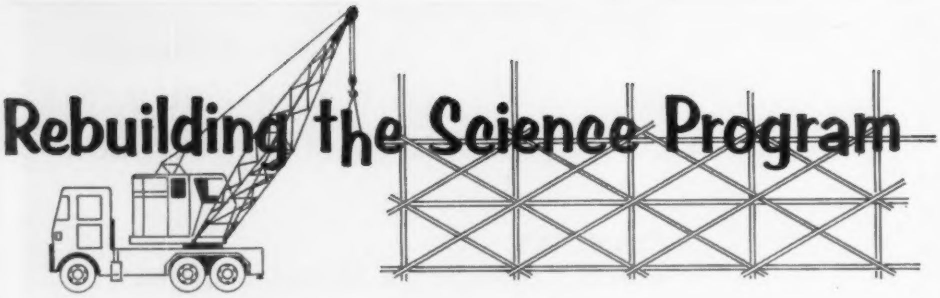


Biology

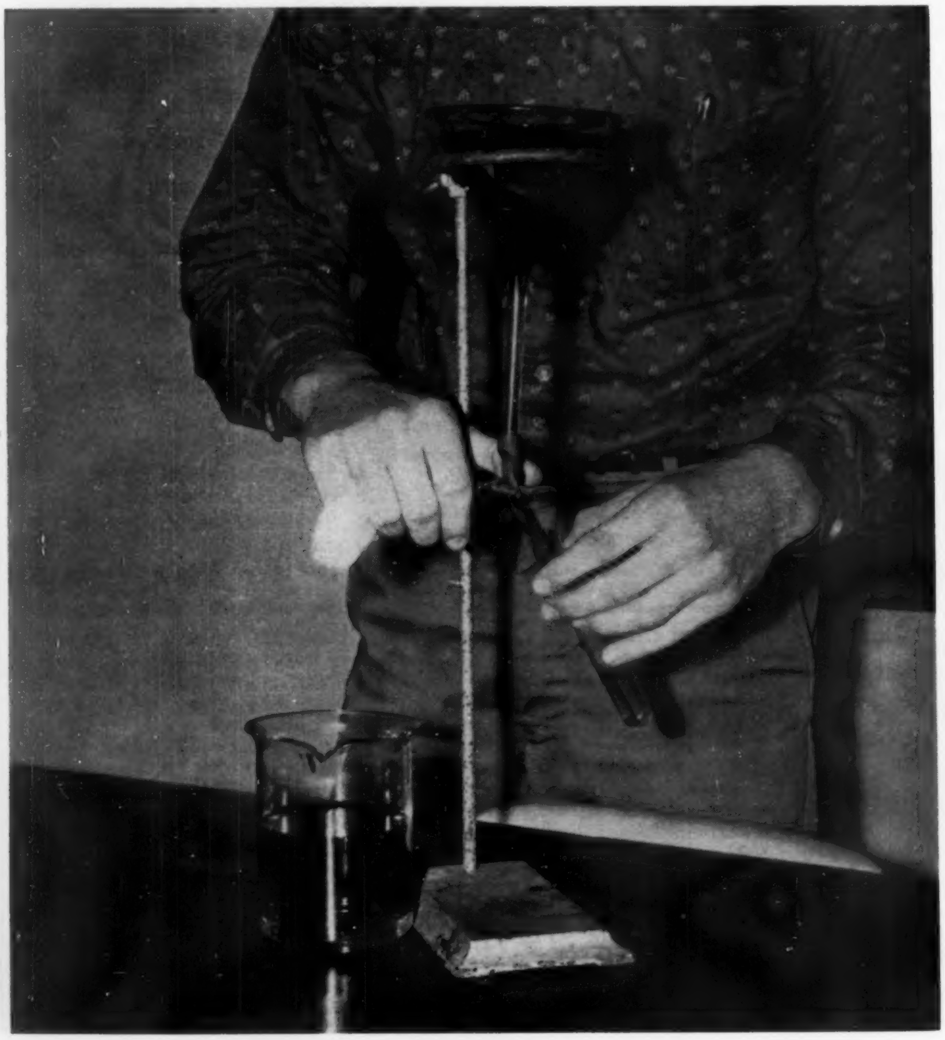
Bacteriology Course

By DAVID L. FAGLE

Biology Teacher, Marshalltown High School, Marshalltown, Iowa

DURING the past two years with the new emphasis being given to science, new areas of student experience have been instituted in many high school biology courses. The significance of bacteriology is becoming more evident, and this subject is being included in the present-day curriculum.

FIGURE 1. Before use, culture media is tubed by a student.



Bacteriology is an area of biology in which the scientific method may be taught effectively. Every student in class may participate in the experiments designed for this study. The value of bacteriology in the high school biology class is that it provides an understanding of the uses man can make of bacteria for beneficial effects, and how to control harmful effects.

The average high school biology course neglects to include a unit on bacteria either because the teachers are not prepared to teach it, or because a school lacks the expensive equipment necessary for teaching such a unit. Teachers will find that advance preparation will give them the needed confidence to guide the students in the investigations. For just a few dollars the necessary equipment can be constructed or improvised, thus allowing a study of bacteriology at the high school level.

The first requirement is to have a media in which bacteria will grow. The best media that may be used is a powdered variety usually obtained through a biological supply house. Such media is generally expensive, but there are many substitutes that may be used. Slices of various fruits and vegetables will work, if properly sterilized. Student participation starts immediately in the preparation of bacterial culture media. Through this beginning, students gain valuable knowledge of scientific measurements and scientific techniques. Figure 1 shows an easy method of tubing culture media. The equipment used is simple enough so that any high school student can set it up and operate it without formal instruction on special techniques.

Before bacterial media can be used by the class, it must be sterilized. Sterilizing the material used in a unit on bacteriology is no problem for the high school class, if use is made of a pressure cooker from the home economics class of the school. Other materials such as improvised glassware, bottles, and tools may be sterilized in a regular cooking oven. The students should not be given the full responsibility of the sterilizing process, but it should be done under the careful supervision of the science teacher.

This report was an entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

FIGURE 2. Sample materials for aluminum-foil Petri dishes.

After the media has been carefully sterilized, some means of containing the culture material for class use is needed. A Petri dish is the most efficient thing to use. Petri dishes can be obtained from any biological supply house. Glass Petri dishes are expensive, easily broken, and a problem to sterilize and clean. New plastic Petri dishes are also on the market, but these are more costly than the average high school can afford.

Aluminum-foil Petri dishes are the answer to the problem of high school biology classes.[1] Figure 2 shows the necessary material employed in making nonbreakable, inexpensive Petri dishes that can be easily sterilized and are completely disposable. One day of class time is spent by the students making Petri dishes, and an elected representative of the class can dry-air oven sterilize the Petri dishes with the teacher's help. After the Petri dishes have been sterilized, they are ready for the immediate use of the class.

The lack of a regulated incubator is often a major hindrance in studying bacteria. A student, mechanically inclined, can make a sturdy, efficient, inexpensive incubator. This can become a permanent part of the equipment in a school laboratory. This incubator can be made from a three-gallon frozen fruit can, some small gauge wire, two lamp sockets, one light plug, two light bulbs, two pieces of two-by-four boards for a stand, one common thermometer, and one bi-metal strip thermostat. The last two items (the most expensive) can be obtained from any supply house. If available, a clothes-iron thermostat or a common household thermometer can be used. A locker plant, hardware store, or lumber yard are sources for other necessary construction materials. The incubator is wired in series. If the construction of such an incubator is too difficult for one student, the project can be initiated as a club project for students. Figure 3 shows the finished incubator constructed for less that eight dollars.

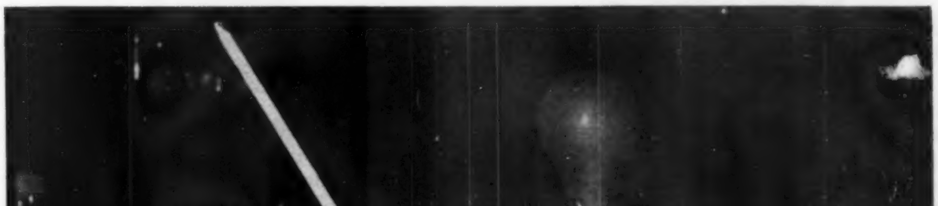
The constructed incubator has many uses in the classroom other than culturing bacteria. Students can use it to hatch chickens, dry plants, or as a warming oven for use in many other biological projects.

Inoculating devices are also necessary tools used in the study of bacteriology. Many simple inoculating devices can be made by students.

Figure 4 shows a simple inoculating needle which can be made by a high school student. A pair of pliers, some nichrome wire, and a common lead pencil are required for constructing parts. With a pair of pliers, the student inserts a six-inch piece of nichrome wire into the eraser of a lead pencil. Another helpful inoculating device is the glass-bacterial spreader. This spreader is used by students making chemical effects assays of a growing culture of bacteria.

Some students are interested in knowing how to stain bacteria, if microscopic examination of cultures is possible. Although it is highly desirable to use regular bacterial dyes, most permanent inks will work sufficiently for high school use.

FIGURE 3. Improvised incubator can be made inexpensively by the students.



[1] David L. Fagle. "Another Use for Aluminum Foil." *The American Biology Teacher*, October 1956.

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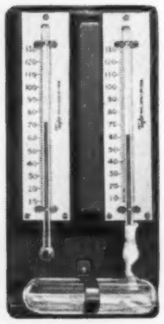

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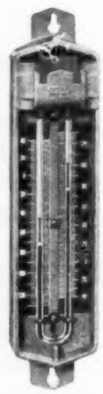

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*Reg. U.S. Pat. Off.

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Since known bacterial cultures are expensive to purchase from a specific culture collection, students may use another source. By writing to the curator of stock cultures of the bacteriology department of some major university near their high school, they will be provided with stock cultures of common nonpathogenic bacterial forms. It is generally found that most college bacteriology departments are willing to help interested high school students in this matter.

Students like to perform bacteriological experiments that are interesting and challenging, but generally can be stimulated to higher scientific achievement when given the opportunity to experiment with some unknown facet of the life functions of bacteria. Currently at our high school, there are a number of students studying the effects of plant-growth stimulators, plant-growth inhibitors, tranquilizers, adrenaline, and aspirin or drug effect on bacteria.

FIGURE 4. Students can easily complete construction of an inoculating needle.

For a start to encourage student interest, try a unit on bacteriology. Let them plan and conduct the unit, but be sure to have many experiments containing unknowns which will stimulate both the teacher and the student.

• • • *Rebuilding the Science Program* • • •

General Science

Laboratory Work—Grades 7 and 8

By RALPH S. VRANA

Science Teacher, New Lincoln School, New York City

FOR the past two years I have worked out a series of laboratory sheets for the students in our school, and have placed the major emphasis on these sheets to teach general science in the seventh and eighth grades. (The two groups are taught together.) This approach has been the most effective one for me in getting the major part of the class involved in science work. While the approach is not new, the problems are of a character which might interest other teachers who would like to experiment with this method. These were the bases from which the work proceeded:

1. Each student should have enough materials and equipment so that he could work out experiments for himself (or at most, with one partner).
2. Emphasis was placed on fundamental principles, which might be illustrated with easily obtainable materials for class quantities.
3. The laboratory sheets were prepared to acquaint students with science phenomena. While the results often were interesting, they were explorations for the student into already well-established fields; a sort of "readiness" program for major laboratory involvement in senior high courses.

The benefits from this approach could be listed as these:

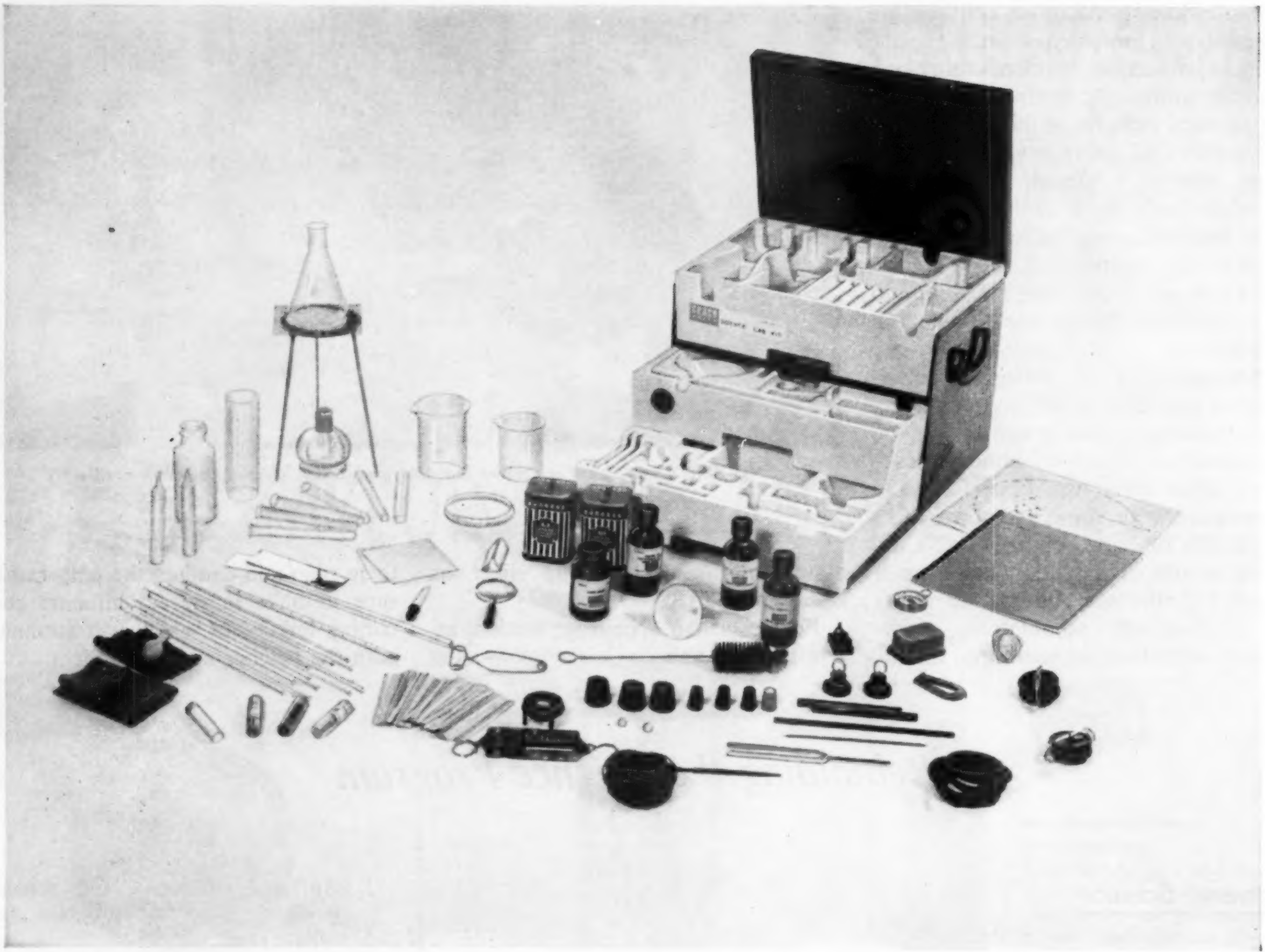
1. Freedom for the teacher to help those who need it without holding back others.
2. An easily checked and reliable guide to students' progress and capacity.
3. A tapping of the student's desire to explore the surroundings for himself; this in a constructive way.

There are also certain handicaps to this approach which might be listed:

1. Accumulating materials in classroom quantities for sufficient experiments for a full-year course can be difficult and time-consuming.
2. There is not time enough for students who show more than average interest in an area to complete the assigned sheet and then to work on his own. Since working from a laboratory sheet is easier, care must be taken to see that a supplement exists.

How does one go about making up a laboratory sheet for seventh- and eighth-grade students, which will teach them some principles of science, and do so in a fifty-minute period? Let us suppose the subject is *heat*. Problems that naturally fall into general science for this age group would be:

1. The measurement of certain temperatures around us.
2. What happens to heated objects?



3. How can heat be produced?
4. What are the means by which measurement of heat is accomplished?

To pursue these problems satisfactorily with laboratory sheets, each student must have a thermometer. The variety in the dime store (29¢) has been found satisfactory for temperatures below 120° F but is distinctly not for use in hot tap water. Once purchased, the actual dimensions and characteristics of the particular thermometer on hand dictate to a large extent what the laboratory sheet would include. Perhaps this goes against the accepted idea that one should plan science activities before purchasing materials, but there is much to be said for a reasonable amount of planning of science activities around available materials. First the general area of study selected, in this case, *heat*. Then a search is made for available and inexpensive materials which will fit in with individual laboratory work. Once these are found, planning should include the exploration of how to use the materials.

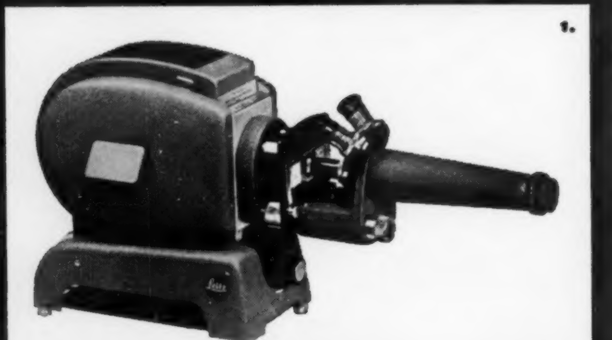
The thermometers used in the class had a range from −46° F to 120° F. Students were asked the range of the thermometer (which was *not* immediately apparent), and to record the present temperature reading they found. (Reporting was done on the laboratory sheet itself, which had been duplicated for class use. Several questions were asked as to what part of the thermometer was most sensitive to temperature changes. This was determined by the student putting his finger on different parts of the thermometer tube. How cold is cold water? This was easily determined by filling a jar with tap water, and inserting the thermometer in it. Where is the warmest part of the room? This also was begun by having students standing on chairs (or tables if possible) and comparing the reading with that obtained on the floor. Sometimes the order of questions is important. If the thermometer is put in water to test its temperature, and then used to test the warmest part of the room, the reading may be in error due to water drops on the bulb.

Further work with the thermometer can easily be undertaken. The temperature of icy water in either the Centigrade or Farenheit reading is easily obtained. We undertook to find how much of a temperature drop could be achieved by adding salt and chopped ice to water. Throughout it all, the student is brought back to the work at hand by the laboratory sheet, which provides him with directions and where to find the materials in the laboratory. We must remember that seventh- and eighth-grade students frequently need explicit help, especially in the use of apparatus unfamiliar to them. Since their experience in a science laboratory is probably nil, this help must be continual, and in the course of the year should include considerable practice in reading thermometers, using filter paper, lighting burners, etc. In this way, the distaste that some students develop through lack of knowledge for unfamiliar materials of the high school physics or chemistry laboratory will be avoided.

Supplementary explanations for most of the questions in the laboratory sheets were not necessary. But those few questions which did bother students for one reason or another, do contribute to many difficulties. Often the

These students are finding out what happens when two floating magnets are placed in a pan of water.

Newspaper photographs and the print on the laboratory sheet itself become the subject of investigation with a microscope. As a result, considerable discussion and student interest can be generated.



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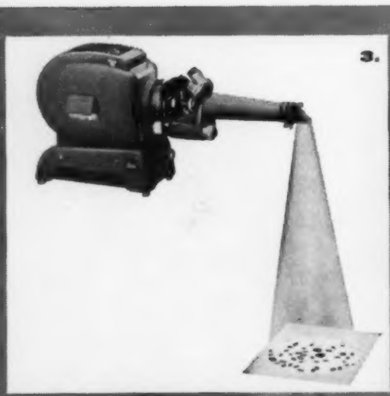

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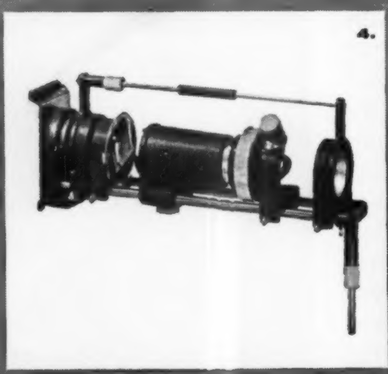

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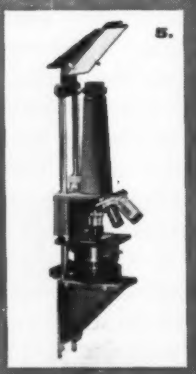

5.

student's hasty reading will be a fault, but there were a few questions basically unclear. I kept a clipboard with a blank laboratory sheet on it to note the questions which confused students. When these laboratory sheets are used again, they will have fewer rough edges.

To maintain a balance, the laboratory sheets were prepared so that for each question some sort of written response is necessary. This response often may be only a "yes" or "no" but the only way to determine a correct answer is for the student to do the work. Some questions might require a sketch, or a more detailed paragraph of explanation. If the student is not asked to report what he has done, he thinks the experiment is unimportant, and is apt to evade the work entirely. Perhaps this is oversimplification, but we must realize the current trend in our living to make life easier. A laboratory sheet which does not ask for specific response may appear to the student as just another TV channel which can be turned off if not found interesting. In other words, I believe it is necessary for the student to learn that the laboratory sheet needs to be completed, not only to benefit himself, but for review or correction by the teacher. It is not heartening to see students working on laboratory sheets *only* because they wish to get the "right" answers to the teacher. No matter how well prepared the sheets are, the student neglects them as he begins his work and the classroom becomes an active center of investigation only.

This microscope is shared by two students who are examining silk cloth magnified 100 times.

There is greater satisfaction, if the teacher has prepared a carefully planned sheet, to know that it is being used and interpreted by each student.

In our school the average class size is 25, and to handle even this many students with laboratory sheets, it is necessary that all materials for the experiment be set out, and *that there be enough of them.* When we list the requirements of the materials involved in this method of teaching, we realize that their acquisition may sometimes cause a problem. They must be inexpensive. They must be readily obtainable. They must be reasonably safe to handle. They must serve in some way to illustrate science principles. They must be simple enough for seventh- and eighth-graders to work with them independently. Those who live in a large city have some advantages in gathering materials, especially in the physical sciences. (New York City has its Canal Street where lenses, prisms, electronic parts, glassware, tools, and much government surplus materials can be had.) The Federal Government has surplus property which it sells at a fraction of cost to schools, and these items can be obtained by any school.[1] There are many books on the market today which provide a wealth of experiments for class use.

[1] Alan Mandell. "Uses of Surplus Property Materials." *The Science Teacher*, 27:32 November 1960.

Provisions for the Slow Learner

By **WILLIAM B. REINER**

Research Associate, Bureau of Educational Research, Board of Education, New York City

WHAT techniques and ideas are useful in teaching science to the slow learner in secondary schools? The answer to this question is important because there are more slow learners studying science than ever before. First, their numbers have increased because the holding power of high schools has doubled in the past twenty years. This has resulted in the retention of thousands of poorer students who normally would have left school. Second, science registration has expanded in response to public pressure as space technology gained in prominence. This, in turn, resulted in a larger science registration of slow learners. Third, there is more concern among educators for the individual differences in students. Attention to the gifted student, therefore, has brought about a sharp awareness of the not-so-bright pupil.

It is hoped that the procedures reported there will suggest fresh approaches to the reader who works with slow learners. For purposes of this presentation, "slow learners are considered to be those students who are distinctly below the average in intellectual capacity, ranking among the lowest 15 to 20 per cent in general intelligence." It is considered desirable to include a relatively large proportion of pupils because teachers do need help, and not just with the extreme few who are mentally deficient.[1]

To improve the science program for the slow learner, three basic procedures are needed. First he must be identified as to capability, then the school or department needs to make administrative arrangements for his science classes, and finally special instructional provisions should be made by the teacher to give the slow learner the fullest assistance possible. Each of these procedures is described briefly in the sections which follow.

Identifying the Slow Learner

Numerous techniques for the discovery of slow-learning pupils have have been reported in research studies. Reviewing these, it is found that the four most common techniques,[2] in order of rankings, reported by teachers, were teachers' marks, group intelligence tests, teachers' estimates of school achievement, and standardized achievement tests. Other techniques in decreasing order of rank were:

1. Information on physical health.
2. Guidance counselor's appraisal of pupils' interests, aptitudes, and abilities.
3. Information on vocational plans.
4. Information on reading interests and habits.
5. Information on home environment.
6. Anecdotal reports and records.
7. Information on personality adjustment.
8. Teachers' estimates of aptitudes.
9. Information on physical maturity.
10. Information on social maturity.
11. Homeroom adviser's appraisal of pupils' interests, aptitudes, and abilities.
12. Information on hobbies.
13. Individual intelligence tests.
14. Teachers' estimates of intelligence.
15. Standardized aptitude tests in specific fields.
16. Parental appraisal of pupils' interests, aptitudes, and abilities.

Which technique(s) should be used will depend on the teacher's experience and interest, the information available about the pupil in school records, the school or departmental policy, and the time available. Evaluation experts generally agree that several clues or criteria for judgment should be employed in identifying the slow learner. It is interesting to note that practices for identifying slow learners were reported as being very similar to those used for discovering rapid learners. Also, large schools (of over 1000 pupils) reported more extensive use of individual intelligence tests, anecdotal records, and guidance counseling in identification procedures.

Administrative Provisions

Administrative procedures for aiding the slow learner involve class organization, assignments of teachers, curriculum adaptation, promotion policies, testing procedures, provision of learning materials and audio-visual aids, and additional items for which the principal or supervisor is responsible to supply the classroom teacher. The five provisions reported by 795 schools as being used exclusively for

[1] "Teaching Rapid and Slow Learners in High Schools." Bulletin 1954, Number 5. U.S. Office of Education, Department of Health, Education, and Welfare. Order from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 1960. p. 3.

[2] *Ibid.*, p. 17.

aiding slow learners, in order of rank, were:[3]

a. Easy study materials related to pupils' interests.
b. Promotion of pupils on basis of physical and social development.
c. Remedial sections where performance is below capacity in basic skills.
d. Low-ability classes in certain subjects.
e. Teachers assigned on basis of training and experience with slow learners.

Other suggested administrative procedures[4] for slow learners, listed in rank order by reporting schools were:

1. Teachers furnished guidance information pertinent to pupils.
2. Teachers assigned on basis of traits and interests suitable for work.
3. Regular classes furnished advanced study materials and additional learning aids.
4. Space, furniture, and equipment for flexible grouping in classes and activities.
5. Ability (homogeneous) classes. (Pupils grouped according to IQ, reading ability, previous grades, social maturity, etc.)
6. Individualized instruction outside of regular class hours.
7. Job placement services.
8. Supervised work experience.
9. Summer-school sessions provided.
10. Credit given for demonstrated achievement regardless of time spent in class.
11. Transfer to special school encouraged.
12. Flexible graduation requirements as to credits.

This list by no means exhausts all possible suggestions. For example, slow learners may be permitted to carry fewer subjects or lighter programs. Other provisions may be the use of a pupil-tutoring squad to assist slow learners, special grading or marking systems, and special testing programs which employ simpler items, nonverbal items, or practical tests. Other useful procedures are described in the literature on administration or methodology.

In general, schools made more administrative provisions for slow learners than for rapid learners and the larger the size of the schools, the more numerous were the administrative provisions made. "The responses indicated that the great majority of effective teachers were organizing instructional materials in large units which facilitated assignments related to interests, needs, and abilities of individual pupils. Probably the most effective teachers were using resource units and teacher-pupil planning of some kind. In the light of what is now known and believed about how children learn, these procedures appear more defensible than some of the rigid and more formal features of the Morrison and Dalton plans."[5]

Instructional Provisions

Thirty effective teaching provisions for the slow learner are presented below, mainly with a view to suggesting procedures that may be used by interested teachers. The top-rated 15 provisions are presented in the rank order of their selection by the 678 schools which responded to a questionnaire from the U. S. Office of Education.[6]

1. Insist that students report science experiments honestly and accurately.

[3] *Ibid.*, p. 9.
[4] *Ibid.*, p. 8 (Also used for rapid learners.)
[5] *Ibid.*, p. 12.
[6] *Ibid.*, p. 54-5.

2. Guide students to note superstitions and other biases that block fair consideration of scientific evidence.
3. Include student activities to stress basic skills, such as reading tables, observing experiments, and spelling common science words.
4. Help students understand scientific reasons for fire-safety rules, sanitary standards, and/or first-aid practices.
5. Discuss with students the qualities that help a person hold a job in industry.
6. Encourage students to read stories about famous scientists.
7. Give students experiences in helping with science demonstrations.
8. Encourage students to collect clippings on the uses made of science in everyday life.
9. Help students to understand how tools, such as the hammer, plane, drill, and screwdriver operate.
10. Guide students to evaluate science notebook work against appropriate standards.
11. Teach students to read and evaluate science materials from newspapers.
12. Encourage students to use scientific encyclopedias and references in preparing science reports.
13. Instruct students to repair simple home appliances, such as toasters, extension cords, and lamps.
14. Encourage students to engage in recreational reading of science fiction.
15. Announce and conduct discussion of radio, television, and movie presentations of scientific events.

The additional 15 instructional provisions reported below for slow learners may be useful to some teachers in certain situations, depending on the pupil's personality or age, the school or community environment and, last but not least, the operational pattern of the teacher. At any rate, these 15 provisions are presented mainly as suggestions for possible approaches with slow science learners.

16. Make use of puzzles and magic in teaching science.
17. Stimulate students to plan and carry on projects of the experimental research type.
18. Use contracts and other methods that provide for learning activities at different levels.
19. Help students to visit establishments where scientific products are made and/or used.
20. Arrange for students to become assistants for class, laboratory, and/or science club work.
21. Help students to analyze science information in statistical form.
22. Help pupils participate in pupil-teacher planning to discover real problems for study in science.
23. Encourage students to participate in adult activities, such as providing information about a sewage disposal system.
24. Encourage students to study the science that underlies proficiency in such special interests as music, art, and history.
25. Help students to participate in local science fairs and congresses.
26. Arrange for doctors, nurses, engineers, and others to meet with science classes.
27. Guide students to know the values of foreign languages for work in the sciences.
28. Arrange for students to try competitive science examinations and aptitude tests.
29. Expect students to make written reports on scientific happenings for the school paper.
30. Arrange for students to attend meetings of science teachers and scientists.

Many other useful procedures may be used besides the 30 which have been listed. For example, self-help materials prepared by teachers, after-school counseling, special-help laboratory sessions, remedial reading work, special make-up work, different levels of textbooks, students caring for plants and animals in the classroom, and intensive audio-visual aids are effective provisions for assisting the slow learner. These do not exclude provisions for special psychological services or liaison with social and community agencies or cooperative, part-time employment plans whereby students earn money on a science-related job while they are still registered in school.

Conclusion

There are no sure cures for the slow learner. Each is an individual in a specific environment. Each has limited capacities. Definitions of slow learners vary. It is the responsibility of the school to find the slow learner and give him the maximum opportunity to develop to his fullest potential. Administrative and instructional provisions should be made. The lists of provisions given in this article may suggest possible approaches for improving the science program for the slow learner in secondary schools.


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Classroom IDEAS

General

A New Look at an Old Experiment

By S. D. HOLMES, Toronto, Ontario, Canada

Critical thinking and independent judgment are acknowledged to be desirable products of instruction in science, but how often are they actually encouraged, or even permitted, by the science teacher. At some stage in dealing with the topic of air pressure you will probably arrange to show your class the standard experiment, a simple one which is in all the textbooks. You fill a glass vessel with water, cover it with a glass plate or piece of cardboard and you invert it, (holding it of course over a sink or wastebasket to show what little faith you have) and the class sees that the water stays in the jar when you remove your hand. If your class is docile, it will accept your explanation that air exerts pressure; that this pressure acts in all directions, upward, downward, and sideways that the upward pressure of the air, fourteen pounds on each square inch of the underside of the card, is greater than the downward pressure on the top including the weight of the water. You will have completed another successful demonstration lesson.

But if your pupils have been trained to think for themselves, they may have some questions to ask. Assuming that you can prove to their satisfaction that air pressure is exerted equally in all directions, what do you do if they ask why you had to keep your hand on the cover until the jar was inverted? Should not the air pressure (acting in all directions, remember) hold the cover on when the jar is held horizontally, or at any angle? This could lead you up a sidetrack involving the question of pressures at different depths in a liquid. And suppose they ask what would happen if the jar contained some air as well as water? You try it, or let them try it, with different quantities of air in the jar and find that the experiment seems to work just as well. Immediately the question arises: Why didn't the air in the jar exert the same pressure downward as the air outside exerted upward? Then the class, as they have been taught, will want to vary the conditions to see if this will make any difference. Differences in temperature (hot and cold water with and without air); different covers (glass, tin, aluminum foil, blotting paper, tissue paper, waxed paper, sandpaper, fine wire gauze); perhaps different liquids; only enough liquid to wet the cover; rough and smooth edges at the mouth of the container; holes in the cover, varying in size from small to large; and so on. How large may the hole in the cover be before air can enter and destroy the balance? Why doesn't the air enter through a smaller hole, or between the cover and the edge of the jar? Is it a safe explanation that the skin of the liquid (call it surface tension if you like; they will be aware of its existence if they have floated a needle or a razor blade on water) opposes the air pressure, in the same way exactly as the material of the cover is doing? Are there any other forces acting? Is there such thing as tension of the air as distinct from air pressure? Can we find a better experiment to illustrate air pressure?

Other experiments are capable of this kind of expansion. If there is no time for them always to be carried on in the science period, every facility and encouragement should be provided for them to be done after hours, in the school or at home, and of course time should always be allowed for a report by the experimenters and a discussion by the whole class.

You may say that all this has very little to do with illustrating the fact that air exerts pressure. Which kind of experiment serves the more useful purpose? You have your choice between the demonstration which the class accepts without question and dutifully records as proving what the teacher says it proves, or the experiment which begets a dozen other experiments, which leads the pupils up some blind alleys, but which engenders some real thinking and independent research and perhaps comes up with new light on the question or ties it in with an entirely unsuspected and different aspect of the subject. There is no doubt which is the more comfortable way to teach, but which is science and which is merely entertainment?

EDITOR'S NOTE: Readers are urged to send in answers to the questions raised in this article. We could publish as LETTERS in TST for the benefit of all teachers. You may also wish to write your comments directly to the author at 1528 Mount Pleasant Road, Toronto 12, Ontario, Canada.

General

Science Quiz

By DONALD D. PREVOST, West High School, Rochester, New York

This report was an entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

This science entry is rather plain, but the teaching value far exceeds most intricate science demonstrations. This is a "Science Question and Answer Board" for use in school corridors or other places.

A "Science Question and Answer Board" placed in a busy section of a school has great potential. Such a science teaching aid reaches all the pupils in the school; it is appropriate for all age and grade levels. (Figure 1.)

By nature, children are inquisitive. The "Question Board," if used properly, will furnish "idea questions" with

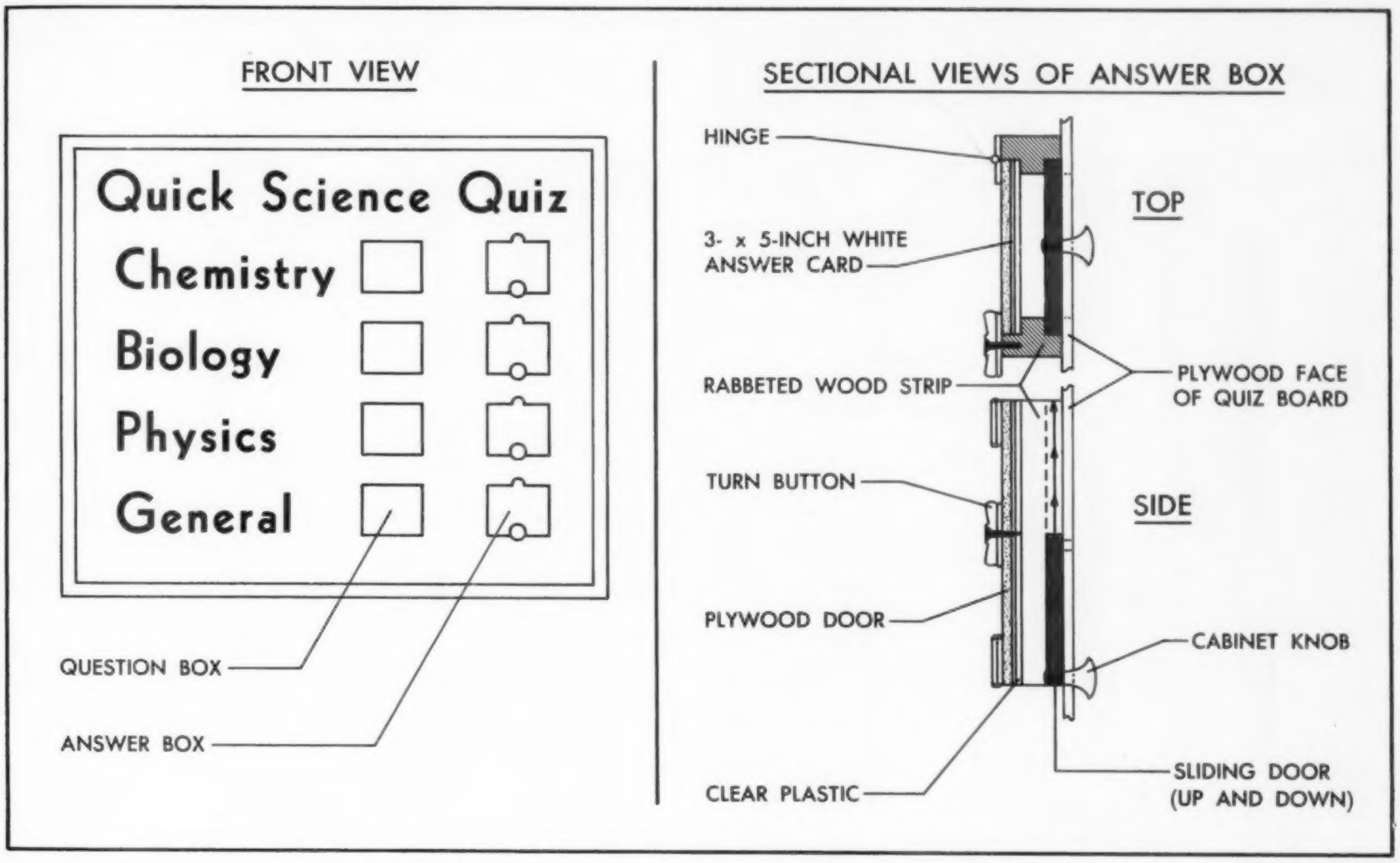

FIGURE 1. Drawing illustrates the "Science Question and Answer Box."

good answers; it will act as a spark for much needed science interest. If questions and answers are the type that will give rise to more questions on the part of the student, the board will have served its purpose.

The "Question and Answer Board" has universal usage. Science, mathematics, English, and social studies departments could utilize such a board. The cost of the project is very low and therefore could be made available to any group or class.

The board can be made out of plywood or masonite. It should be framed in back to give it added strength.

The doors of the answer side should be constructed by using the sliding panel type. The sliding panel door will drop back into place after use, whereas a hinged door might stay open.

The board should be placed at eye level so it is easy to see and operate. The lower-grade subject matter should

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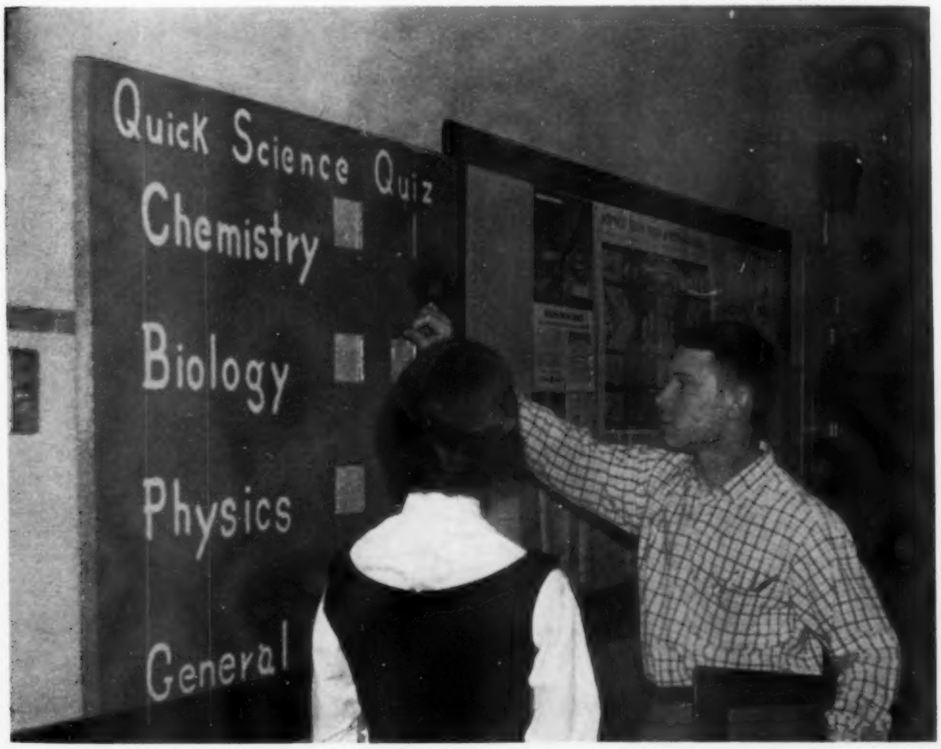

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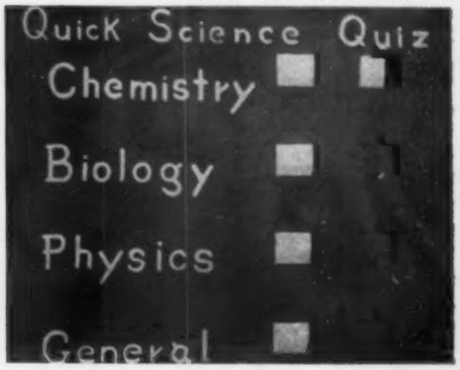


be located at the bottom of the board to allow the elementary students easy excess to the panels. The lettering should be bold and bright in color to attract attention.

The board can be mounted on hinges so it can swing away from the wall to allow for the change of questions and answers. Questions and answers should be changed at least once a week.

If you try this, you will agree that such an item of interest in the halls of your school would attract attention by the students. It is an inexpensive experiment that produces an end result: searching questions to help stimulate the minds of our future scientists.

General

Color Mixing on the Overhead Projector

By PAUL REBER, John Adams High School, South Bend, Indiana

Color by addition or color by subtraction is easy to show on the overhead projector in this demonstration.

Preparation:

Provide eight or more Petri dishes of glass or clear plastic approximately 5 cm in diameter; several small pipettes (medicine droppers); a stirring rod; four small beakers (100 ml to 200 ml) or small glass jars; a food coloring set of four colors, red, yellow, blue, and green. Food coloring may be purchased at any grocery store for less than fifty cents.

To provide four beakers of stock solution, each of a different color, red, yellow, blue, and green, mix about 100 ml of water and 4 or 5 drops of coloring material.

Demonstration:

1. Arrange four Petri dishes in a row so the image of this row is along the top of the screen. Half fill these dishes so a dish of each color is provided as a standard for comparison. Half fill four more Petri dishes in a similar manner from the stock solutions and use these dishes for manipulation during the demonstration.

2. Combinations of two or more colors may be shown by merely stacking the Petri dishes containing the selected colors. Several different combinations may be shown simultaneously by arranging the Petri dishes in such a manner that an additional color may overlap several original colors. Variation in color shade may be made by varying the amount of coloring material per 100 ml of solution. Also by use of the pipette, different colors may be added to any chosen dish to obtain various shades or combinations.

Any clear dish may be used but Petri dishes have the advantage in stacking neatly and the bottom of one will not become wet from the solution in another dish. Many combinations and arrangements will occur to the demonstrator as experience is gained.

Several Petri dishes of larger diameter make overlapping more convenient. By careful addition of coloring material in seven different dishes the colors of the spectrum may be provided. Solutions need not be discarded but may be used for successive classes, and if kept in closed containers may be stored for use in future demonstrations.

Convention NOTES

As this report goes to press, the General Program Committee of NSTA's Tenth Annual Convention has completed plans in San Francisco for a program of six eventful days, perhaps never equaled in the history of the Association. Reviewing the tentative schedule and knowing the intensity and interest being developed to forge the activities of the membership into a dynamic leading force in science education, we are certain that YOU WILL WANT TO PARTICIPATE IN THIS HISTORY-MAKING EVENT.

Purposes, organization, and dates (March 9-14) have been worked out by the Program Committee; the effectiveness and impact are up to you. We need your help and support in realizing the full potential of this convention.

Panel Presentations

Panel Presentations will focus on five major areas of concern:

1. Curriculum. Under the chairmanship of Fletcher G. Watson, Harvard University, Cambridge, Massachusetts, participants from various areas will include J. Myron Atkin and R. Will Burnett from the University of Illinois, Urbana; Alfred D. Beck, Board of Education of the City of New York, Brooklyn; Donald G. Decker, Colorado State College, Greeley; Philip G. Johnson, Cornell University, Ithaca, New York; Rose Lammel, Wayne State University, Detroit, Michigan; Addison E. Lee, University of Texas, Austin; and Elizabeth Ann Quinn, Saxe Junior High School, New Canaan, Connecticut.

2. Staffing. Chairman, Helen E. Hale, Baltimore County Public Schools, Towson, Maryland, to be assisted by Robert D. Binger, State Department of Education, Tallahassee, Florida; Marjorie P. Behringer, Alamo Heights High School, San Antonio, Texas; Ruth E. Cornell, Public Schools, Wilmington, Delaware; Alfred B. Garrett, The Ohio State University, Columbus; William Ramstadt, Stanford University, Stanford, California; Albert Piltz, U. S. Office of Education and Ray C. Maul, National Education Association, both from Washington, D. C.

3. Programing. Chairman, Donald W. Stotler, Public Schools, Portland, Oregon, will have the following conferees: Milo Blecha, University of Arizona, Tucson; Richard L. Miller, Los Angeles City Board of Education, Los Angeles, California; Clyde E. Parrish, Cubberley High School, Palo Alto, California; Robert Stollberg, San Francisco State College, San Francisco, California; Harold E. Tannenbaum, Yeshiva University, New York City; and John Sternig, Public Schools, Glencoe, Illinois.

4. Evaluation. With Chairman John M. Mason of Michigan State University, East Lansing, will be Norman Crowder, United States Industries, Inc., Aoleta, California; Fred Ferris, Educational Testing Service, Princeton, New Jersey; John Flanagan, American Institute of Research, Pittsburgh, Pennsylvania; Clarence H. Nelson, Michigan State University, East Lansing; John G. Read, Boston University, Boston, Massachusetts; Wilian B. Reiner, Board of Education of the City of New York, Brooklyn; and Brother U. Alfred, F.S.C., St. Mary's College of California, St. Mary's College, California.

5. Instructional Materials and Facilities. Chairman Stanley E. Williamson, Oregon State University, Corvallis, will head the group which includes James D. Finn, University of Southern California, Los Angeles; John S. Richardson, The Ohio State University, Columbus; Henry A. Shannon, North Carolina State College, Raleigh; and Samuel Schenberg, Board of Education of the City of New York, Brooklyn.

As outgrowths of followups of these panels, smaller discussion units will be formed in each area. These groups will provide the opportunity for every convention participant to "speak his mind" and influence the final product of the total effort. The panel chairmen have produced advance working papers for all NSTA members so that each may be fully informed prior to coming to the convention. These working papers will be sent to the membership through the NSTA Packet Service to be distributed about January 22.

General Sessions

Through the general sessions, the panels, and the discussion groups, all participants will share in formulating a series of resolutions and recommendations for presentation to the Policies Committee of NSTA. This will be the most important purpose of the convention, and is designed for everyone to contribute to the future of NSTA in setting guidelines and directives.

Curriculum Center

Two important facets of the meeting will provide every science teacher in the elementary, junior high, and senior high grades, and in general education programs at the college level, ample opportunity to improve and enliven their current operations and approach to science education. One will be the comprehensive display of recently developed courses of study and curriculum guides for all areas and levels. This activity is under the chairmanship of Paul DeHart Hurd of Stanford University. The purpose of the Curriculum Center is to make it possible for science teachers to examine outstanding curriculum materials developed by local and regional committees. Dr. Hurd and his committee earnestly seek all possible information about any recently developed materials to be displayed in the Curriculum Center.

Write immediately and advise Dr. Hurd of any materials which your school or school system may have. Specifically, the request is for courses or teaching units in elementary school science; general, earth, or physical science; biology; physics; chemistry; advanced placement courses in each of the special sciences; college science courses intended for general education; and policy statements or curriculum guides.

Deadline for receipt of materials to be displayed is *February 28, 1962*. It is not possible for NSTA to pay for the shipment of materials to and from the Center, or to guarantee the return of these materials after the convention. For more details and final arrangements write to Dr. Paul DeH. Hurd, School of Education, Stanford University, Stanford, California.

The second of these special services will be a display of novel demonstrations and experiments that have been devised by practicing teachers for their own approaches and objectives. These will be displayed in conjunction with the Curriculum Center. Teachers who may wish to contribute to this display should write to the Chairman, John W. Renner, at NSTA headquarters.

Innovations

Important innovations in science teaching will be described in a series of parallel sessions under the chairmanship of J. Myron Atkin, University of Illinois, Urbana, who will speak on the Illinois Elementary School Science Project. Also, Gilbert C. Finlay, University of Illinois, Urbana, will discuss new approaches in

junior high school science; Abraham Fischler, Harvard University, Cambridge, Massachusetts, will talk on science and team teaching; Arnold B. Grobman, University of Colorado, Boulder, will give the latest report on the Biological Sciences Curriculum Study; and Robert Karplus, University of California, Berkeley, will outline the California Elementary School Science Project. Other presentations will be made by Dorothy C. Matala, Iowa State Teachers College, Cedar Falls, on the American Association for the Advancement of Science special teacher project; Herman Schneider, City College of New York, New York City, on mathematics in elementary science; Laurence E. Strong, Earlham College, Richmond, Indiana, on the Chemical Bond Approach Study; and J. Richard Suchman, University of Illinois, Urbana, on inquiry training in science.

NSTA Sections

A one-day workshop under the auspices of the Business-Industry Section has been planned to demonstrate the latest and most effective practices in industry-sponsored science teaching aids. Items to be displayed have been carefully selected to introduce tools, techniques, and materials to help the science teacher.

The Association for the Education of Teachers in Science and the National Science Supervisors Association, now both sections of NSTA, have planned full-day programs of special interest to the members working in these areas.

Youth Science Congress

Developed as an activity of NSTA's Future Scientists of America program, a Youth Science Congress will be offered for FSA members from the San Francisco Bay area. The Chairman, Russell Archerd of Calistoga High School, Calistoga, California, is also President of the California Science Teachers Association, Northern Section.

Future Science Teachers

Especially designed for college students preparing to be science teachers, this program will be developed and chaired by Robert Stollberg of San Francisco State College, San Francisco, California.

Films and Audio-Visuals

Under the capable direction of H. Seymour Fowler, review editor for *TST* from The Pennsylvania State University, University Park, many of the most recent science teaching films and other audio-visuals will be shown. Several hours of screening time have been alloted, and the schedule of showings will be given in the printed program to allow teachers to make selections without conflicts.

Science Teaching Materials Exposition

The annual Exposition of Science Teaching Materials is made possible through the cooperation of many producers and purveyors of such products. This year approximately 150 booths will be devoted to displays of textbooks, charts, laboratory equipment, audio-visual materials, business-sponsored aids, classroom supplies, and related materials. This annual display is always a feature of the convention, and this year promises to be the most extensive in ten years.

Special Features

The Annual Banquet will begin with introductions from the toastmaster, NSTA President, J. Darrell Barnard of New York University. The featured speaker for this function will be announced, along with speakers for all of the general sessions, in the special convention insert in the December issue of *TST*.

A luncheon for elementary teachers has been planned by Chairman J. Myron Atkin, University of Illinois, Urbana. Classroom teachers, supervisors, admintrators, and others consider this one of the most valuable means of exchanging ideas, information, and other data with fellow participants. As usual, it will also present as speaker a national leader in current developments in elementary science teaching. The Elementary School Science Association of Northern California, an affiliate of NSTA, will cosponsor this luncheon. President of ESSA is Joseph J. Kotrlik of Sacramento Public Schools, Sacramento, California.

NSTA CALENDAR

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST*'s calendar editor as early as possible.

November 5-11, 1961: American Education Week, Theme: Your School—Time for a Progress Report

November 23-25, 1961: 61st Annual Meeting, Central Association of Science and Mathematics Teachers, Sheraton Chicago Hotel, Chicago, Illinois

December 26-30, 1961: NSTA Annual Winter Meeting in conjunction with 128th meeting of the American Association for the Advancement of Science, Denver, Colorado

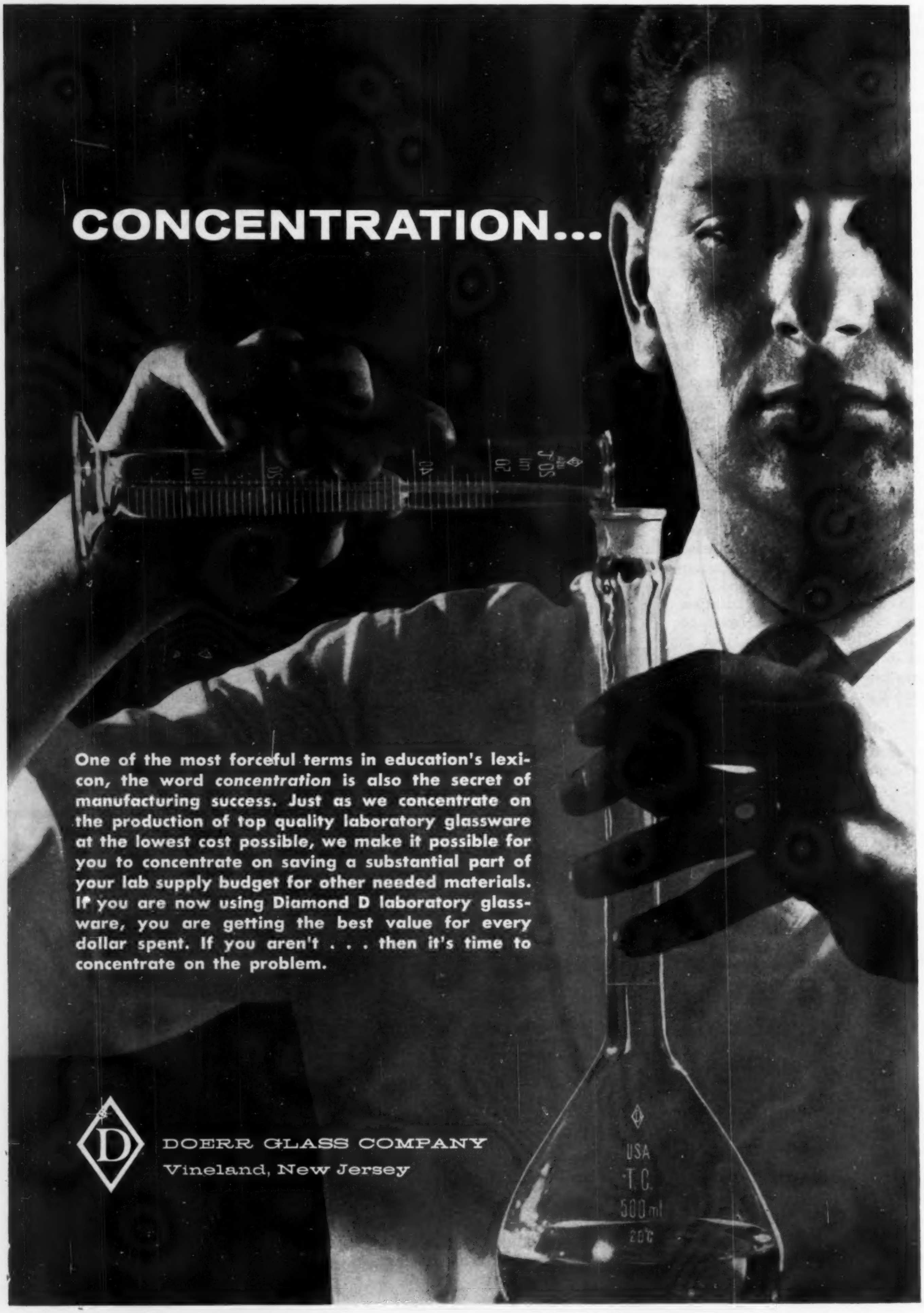
January 22-26, 1962: Annual Meeting, American Meteorological Society, New York City

January 24-27, 1962: Annual Meeting, American Association of Physics Teachers, Statler-Hilton Hotel, New York City (Joint meeting with the American Physical Society)

February 21-24, 1962: 35th Annual Meeting, National Association for Research in Science Teaching, Willard Hotel, Washington, D. C.

March 9-14, 1962: NSTA Tenth Annual National Convention, San Francisco, California

April 15-18, 1962: 40th Annual Convention, National Council of Teachers of Mathematics, Jack Tar Hotel, San Francisco, California


CONCENTRATION...
One of the most forceful terms in education's lexicon, the word *concentration* is also the secret of manufacturing success. Just as we concentrate on the production of top quality laboratory glassware at the lowest cost possible, we make it possible for you to concentrate on saving a substantial part of your lab supply budget for other needed materials. If you are now using Diamond D laboratory glassware, you are getting the best value for every dollar spent. If you aren't . . . then it's time to concentrate on the problem.
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NSTA Activities

Board of Directors, 1961–1962

The eighteenth annual business meeting of the NSTA Board of Directors was held July 7-9 at the NEA Headquarters Building, Washington, D. C. As would be expected when more than twenty individuals participate, there was much serious discussion of approximately thirty agenda items, nearly forty committee reports, and a number of other problems and issues which emerged as the meeting progressed. Action was taken on more than fifty specific motions. In line with our customary practice of reporting to the membership at large, the most significant Board actions are herewith presented in capsule form. Members interested in more details will be sent a copy of the complete, official minutes upon request to the Executive Secretary.

1. Approved the recommendation that the Policies Committee during 1961-62 develop proposed policy statements on some twenty issues or aspects of science teaching and present these for consideration by the Board at the 1962 meeting. (Members desirous of knowing more about this project or perhaps participating in some manner should contact the committee chairman: Dr. Milton O. Pella, University of Wisconsin, Madison, Wisconsin.)

2. Voted to invite the chairmen of NSTA Sections to attend the 1962 Board Meeting as participating but non-voting consultants.

3. Approved the proposal of the Curriculum Committee for a five-year project to produce resource materials for use by teachers, supervisors, and others concerned with the development of K-12 science programs in the schools. (Those interested to be associated with this project in a consulting role should write to the Executive Secretary and ask to be placed on the mailing list.)

4. Authorized appointment of a Publications Committee with the charge to study needs and to develop a long-range plan for the production and publication of bulletins, monographs, and other appropriate publications by NSTA.

5. Directed that an exploratory national advisory conference on science teaching be held in conjunction with the 1962 Board Meeting, the participants to be official delegates representing NSTA state chapters and other affiliated groups.

6. Rejected a proposal from a publishing house that NSTA accept funds with which to staff and supervise a project to produce a junior high school level encyclopedia of science to be marketed on the basis of royalties to NSTA.

7. Voted to hold the 1962 Board of Directors Meeting in Seattle, Washington, partly in recognition of NSTA's participation in the "Century 21" Exposition reported in September *TST*.

Business–Industry Section

The program of the Business-Industry Section of NSTA for 1961-62 includes an extensive distribution of science-oriented teaching materials among the membership of the Section. This effort has a two-fold purpose:

(1) to bring to the attention of educational representatives of business-industry groups the wide array of instructional materials being produced, and

(2) to improve the quality and quantity of materials available to science teachers.

Guiding the planning of activities of the Section for the coming year, including participation in the San Francisco Convention, is the Executive Committee which includes these officers elected to serve for 1961-62: *Chairman,* Albert L. Ayars, Hill & Knowlton, Inc., New York City; *Vice-Chairman,* Allison J. McNay, Standard Oil of California, San Francisco; *Secretary,* Catherine R. Ready, Bristol-Myers Company, New York City; and *Treasurer,* John P. McGill, American Trucking Associations, Inc., Washington, D. C. The Executive Committee also consists of additional members who participate actively in this area.

AAAS Meeting

Remember to jot down on your calendar and plan to attend the annual joint meeting of NSTA and other science teaching societies affiliated with the American Association for the Advancement of Science.

Date: December 26-30, 1961
Place: Shirley Savoy Hotel
Denver, Colorado

Those planning to attend should make their hotel reservations through the AAAS Housing Bureau, 225 West Colfax Avenue, Denver 2, Colorado. Details of the sessions of the teaching societies, as well as those of scientific societies meeting with AAAS, will be published in the AAAS General Program. No separate program for the science teaching groups will be printed. See the October *TST* for full information on all five NSTA sessions planned in accordance with the general theme "Vistas of Science."

In addition to the five NSTA sessions, three joint meetings will be held with the National Association for Research in Science (NARST), the National Association of Biology Teachers (NABT), and the American Nature Study Society (ANSS).

All NSTA members, and anyone interested in the teaching of science are invited to attend the meetings.

Change in Bylaws

During the annual meeting of the Board of Directors, the following changes were approved in Article V, Section 2 of the NSTA Bylaws. The revised material is given below. We would like to have the membership indicate their approval by postcard ballot. Please mail to NSTA headquarters by ***December 1, 1961.***

The wording should read: "I favor the Amendment" or "I am opposed to the Amendment." Insert your signature and address, and mail postcard to the Executive Secretary.

Proposed Change: Article V, Section 2. The President, President-elect, and Retiring President shall serve for one year. The Recording Secretary and the Finance Officer shall serve for two years. All officers shall take office at the adjournment of the next Annual Business Meeting following their election. The Recording Secretary shall be elected in even-numbered years and the Finance Officer, in odd-numbered years. The President-elect-elect and the Finance Officer-elect (or the Recording Secretary-elect) become voting members of the Board of

Directors on June 1 following their election and are entitled to all rights and privileges enjoyed by other members of the Board including per diem, transportation, and other expenses incurred to attend the Annual Business Meeting.

The reason for the change became necessary when NSTA became the *National Science Teachers Association, Inc.* Under this title, the constitution and bylaws were replaced by a Certificate of Incorporation and Bylaws. In this transition, the length of the term of office and the time of election of the Recording Secretary and Finance Officer were inadvertently omitted. The Section under Article V at the time read as follows: Officers, except the Recording Secretary and Finance Officer, shall serve for one year and shall take office at the adjournment of the next Annual Business Meeting following their election. However, the President-elect-elect and the Finance Officer-elect (or the Recording Secretary-elect) become voting members of the Board of Directors on June 1 following their election and are entitled to all rights and privileges enjoyed by other members of the Board including per diem, transportation, and other expenses incurred to attend the Annual Business meeting.

FSA Organization

The Future Scientists of America program, like all other NSTA activities, operates with the guidance of NSTA members. The Chairman of the FSA Steering Committee for 1961-62 is Rolland J. Gladieux, Director of Science and Mathematics, Kenmore Public Schools, Kenmore, New York. Other members of the committee are: Leona K. Adler, New York University, New York City; Theodore W. Beck, El Cerrito High School, El Cerrito, California; Virginia A. Daniels, Latrobe High School, Latrobe, Pennsylvania; Kenneth B. Hobbs, the Educational Services Division of the National Aeronautics and Space Administration, Washington, D. C.; Paul B. Hounshell, Winston-Salem City Schools, Winston-Salem, North Carolina; Richard S. Smith, Haverford, Pennsylvania, (presently at the University of Oregon, Eugene).

Guidebook

The section of the Sponsor's Guidebook which includes student projects will be sent to all FSA Chapter Sponsors early in 1962. Victor Showalter and Irwin Slesnick of The Ohio State University, Columbus, are producing the manuscript. It will be a combination of the most useful sections of the publications *Encouraging Future Scientists, Student Projects,* and *If You Want to Do a Science Project,* as well as abstracts of winning entries in the 1961 FSAA competition. The material in the Guidebook will be distributed also as a separate publication and a regular sales item.

The 1958 publication *Encouraging Future Scientists, Student Projects* (Stock No. 47-126) has been reprinted to meet the numerous requests for copies. It may be purchased for fifty cents a copy. Together with the Guidebook, it makes an extremely useful source for students who plan to enter the FSAA competition. See page 52.

Youth Conference on the Atom

The 1961 National Youth Conference on the Atom will be held at the Palmer House in Chicago, Illinois, on November 9, 10, and 11. About 300 high school students have been chosen to attend the conference for their interest and excellence in science, and more than 200 outstanding high school teachers will participate also.

The purpose of the Conference is to present to a group of the nation's most gifted high school science students and teachers an authoritative and inspiring picture of the promise of the peaceful atom in its various applications, and to help advance interest in the study of science in the United States. Students and teacher-delegates selected on the basis of their achievements, will be sponsored by some 60 investor-owned electric utility companies of the various states. Co-sponsors for the conference are the National Science Teachers Association and the Future Scientists of America.

Active cooperation has been obtained from a number of prominent academic organizations to assure the reporting of current and accurate information on the developments in the nuclear science areas. Keynote speaker for the Conference is Hans A. Bethe, Laboratory for Nuclear Studies, Cornell University, Ithaca, New York. Dr. Bethe is the recent winner of the $50,000 Enrico Fermi Award. Nobel Prize winner, Glenn T. Seaborg, Chairman of the Atomic Energy Commission, Washington, D. C., will be the featured dinner speaker. John H. Marean, NSTA President-elect, Reno High School, Reno, Nevada, will be the presiding moderator at the First General Session on "The Inter-Relationships of Science."

In addition to the formal program, students and teachers will tour the Atom Fair being held in Exhibition Hall at the Conrad Hilton Hotel, and atomic energy facilities at Argonne National Laboratory and the Dresden Nuclear Power Station. Meetings have been arranged with the "working" nuclear scientists at these locations to discuss current achievements and research in the nuclear science fields.

BOOK Reviews

Biological Education in American Secondary Schools 1890-1960. Paul DeHart Hurd. 264p. $4.75. American Institute of Biological Sciences, 2000 P St., N.W., Washington 6, D. C. 1961.

The developments in high school biology from 1890 to the present are reported. The author indicates that only curriculum developments plus classroom and laboratory learning are topics for discussion in the book. This is one of a proposed number of studies conducted for the American Institute of Biological Sciences. The study was supported by a grant from the National Science Foundation. Let us first consider the materials which are included other than the printed text. Here, reference is made to a Bibliography of Committee Reports and a Bibliography of Research Studies. For the student of biology education, both of these sections at the end of the book, (pp. 247-263) have special importance. The Bibliography of Committee Reports is an exhaustive list of reports which directly or indirectly affected the development of high school biology teaching in the United States. This list alone would be worth the price of the book to the student of the history of science teaching. It includes a listing of all the major, and some minor, reports of studies of biology education. Over 150 research studies are reported in the Bibliography of Research Studies. These cover a variety of aspects of the teaching of biology. Collectively, they represent a complete coverage of the topic. The text material then discusses in detail events and procedures for which reference is made in the bibliographies. Section I considers Committee Reports chronologically in the following order: Biology Education, 1890-1960; The Beginning of General Biology, 1900-1910; The Changing Science Curriculum, 1910-1920; A Period of Curriculum Refinement, 1920-1930; A Period of Questioning, 1930-1940; Biology in General Education, 1940-1950; The Crisis in Science Education and a Reappraisal, 1950-1960. These are chapter headings for Section I. Their titles illustrate the author's historical treatment of developments. The second section, Part II, deals with Research Studies for which a Bibliography of references has been mentioned earlier in this review. Again, chapter titles describe effectively the content of this portion: Books on the Teaching of Secondary School Biology, Investigations on the Objectives of High School Biology, Investigations of Criteria for the Selection of Course Content, Investigations of Biology Textbooks, The Learning of Biology, Instructional Resources for Teaching Biology, Unresolved Problems in Biological Education, and Problems and Issues in Biology Teaching. When one reads the titles of the chapters in Part II, one is immediately impressed with the complete coverage of the field demonstrated by the author. A science educator visualizes a rather complete seminar in biology teaching from the contents of Part II. This reviewer sees this section as an excellent source of ideas for a complete and sophisticated treatment at the graduate level of the research related to biology education. This reviewer calls attention to one area after studying the author's treatment both of the historical aspects of biology education and of pertinent research studies in the field. Little or no reference is made to the contributions made by the leaders in the Nature Study Movement to secondary school biology. No reference is made to contributions from such great leaders as Comstock, or Bailey, or Palmer. These three leaders plus others from the Nature Study Movement are recognized as having produced a profound effect on developments in biology. Perhaps these contributions were overlooked since many of them were directed toward the rural school and a rural environment. Nevertheless, this movement, at the public-school level, established the early beginnings of ecology, conservation, and outdoor education. All of these movements play an important role in today's secondary school biology program. There has been, for many years, a need for an organized treatment of high school biology teaching. This volume accomplishes this. To understand the present and at the same time establish its relationship to the past is extremely difficult. Dr. Hurd has helped us do this for biology education by his careful and chronological treatment of events. To anticipate the future is even more difficult. However, again the author helps us visualize some of the problems in biology education which will confront us. Chapter XVI, Problems and Issues in Biology Teaching, help us look to the future. The author has listed, it appears, *twenty* of the most important problems of the future in this chapter. Answers to these problems may write the history of biology education 1960-70 and probably even into several decades beyond 1970. This is an excellent report. It is strongly recommended, as required reading for all biology teachers in-service and in-training. It should also be helpful to school administrators and to college teachers who need to understand the high school biology program. The concise treatment of the AIBS Biological Sciences Curriculum Study and the new courses which are being developed in this program would be useful to all groups interested in public school education. This is only one of the many developments with which the reader will become familiar. Others have been mentioned earlier in this review.

H. Seymour Fowler
The Pennsylvania State University
University Park, Pennsylvania

ANNOUNCING . . .

1. Graduate Courses in Botany.

High school biology teachers applying for National Science Foundation Summer fellowships will be interested in an expanded summer program of graduate courses in botany. Beginning with the summer of 1962 and in alternate years, the curriculum will consist of Plant Taxonomy for the first six weeks and in the second six-week period, Plant Physiology and Plant Ecology. Write the Department of Botany, University of North Carolina, Chapel Hill, North Carolina. Application forms for NSF Summer fellowships will be accepted from the National Science Foundation, Washington 25, D. C., to January 5, 1962.

2. Visiting Professors Program in Astronomy.

During 1961-62, the American Astronomical Society, under a grant from the National Science Foundation will continue its Visiting Professors Program. Send all requests as follows: In the East to Franklyn M. Branley, The American Museum-Hayden Planetarium, New York 25, New York; In the Middle-West, Victor M. Blanco, Case Observatory, East Cleveland 12, Ohio. In the West, Seth B. Nicholson, Mount Wilson and Palomar Observatories, Pasadena, California.

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee

Chairman: Dr. H. Seymour Fowler

The Pennsylvania State University, University Park, Pennsylvania

BOOK BRIEFS

Man in Nature. Marston Bates. 116p. Paperbound $1.50, Cloth $2.95. Prentice-Hall Inc., Englewood Cliffs, N. J. 1961.

One of the excellent volumes in the "Foundations of Modern Biology Series." Describes physical, behavioral, and cultural characteristics of man. Introduces the lower primates and treats their evolution. Describes human populations. Excellent chapter on Ecology and Economics. Conservation philosophy is encountered frequently. Recommended for more capable high school biology students and as a worthy addition to the high school biology teacher's reference shelf.

One Hundred and One Experiments with Insects. H. Kalmus. 194p. $2.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

Interesting introduction is given in which there is a contrast between the human and the insect body. Divided into chapters in which the various aspects of insect life are studied through practical experiments. A good collection of well-explained experiments describing the metabolism, digestion, respiration, locomotion, cuticle and epidermis, mechanical and chemical senses, effects of gravity and temperature, reaction to light, growth and development, behavior, and studies of populations of insects. A list of biological supply houses is included. Drawings help to make it a valuable addition to the library of a biology laboratory classroom. Serves as reference book for high school students interested in insects.

Teaching Guide for the Earth and Space Science Course. Prepared at the request of the Bureau of Curriculum Services by a subcommittee of the Pennsylvania Earth and Space Science Course Advisory Committee. 104p. $1. Order from National Aviation Education Council, 1025 Connecticut Ave., N.W., Washington, D. C. 1959.

Curriculum directors who are revising and updating their own science courses will find this book an excellent stimulus in planning a program incorporating the new emphasis on space exploration. The Pennsylvania Department of Public Instruction does not regard the grade placement of the Earth and Space Science Course as fixed. The course may be presented as a preparatory course laying the foundation for later specialized work or as a terminal course for general education purposes. The book contains four main sections: The Changing Earth, The Earth in Space, Weather and Climate, and The Oceans.

The Autobiography of Science. Revised Edition. Edited by Forest Ray Moulton and Justus J. Schifferes. 748p. $5.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

A collection of over 100 choice excerpts from the writings of eminent scientists whose works follow the development of scientific thought from antiquity up to the present day. Some of the scientists included are Hippocrates, Aristotle, Archimedes, Galen, Roger Bacon, Copernicus, Galileo, Harvey, Huygens, Newton, Linnaeus, Lavoisier, Franklin, Faraday, Darwin, Lister, J. J. Thompson, Einstein, Planck, Bohr, Schroedinger, Freud, Fermi, Oppenheimer and Von Braun. Topics include all areas of scientific endeavor. An invaluable addition to a science teacher's library. Recommended as supplementary reading from secondary school through college. Also interesting for laymen.

Mammals of Wisconsin. Hartley H. T. Jackson. 504p. $12. University of Wisconsin Press, Madison 6, Wis. 1961.

Although this book covers mammals of a specific region, it is useful in other parts of the country. For biology teachers or the nature enthusiast, the sections on common names, identification, criteria, and descriptions are useful. Contains line drawings or photographs of skulls, teeth, and other diagnostic parts. Has illustrations of nests, scats, tracks, and burrows. Equally useful to the high school biology teacher is information concerning habits of the mammals, their economic importance, and their management. Excellent bibliography is included.

Junior Science Book of Magnets. Rocco V. Feravolo. Illustrated by Evelyn Urbanowich. 62p. $2.25. The Garrard Press, 510 North Hickory St., Champaign, Ill. 1960.

The author explains what a magnet is and how it works. Simple directions show how to perform many experiments with bar magnets and electromagnets. The young reader will learn how magnets have changed the world. Interest level would be approximately the sixth grade.

Junior Science Book of Light. Rocco V. Feravolo. 62p. $2.25. The Garrard Press, 510 North Hickory St., Champaign, Ill. 1961.

Describes a variety of activities youngsters in grades 2-8 would enjoy doing. Pinholes, prisms, sundials, and shadows are but a few of the interesting experiences included. A readable text (according to the Spache Readability Formula Grades 2-5) and mono-

chromatically green illustrated line drawings make this an acceptable contribution to the supplementary science reading shelf of the classroom or school library.

History of the Earth. Bernhard Kummel. 610p. $8.75. W. H. Freeman and Company, 660 Market St., San Francisco 4, Calif. 1961.

This college text should give the student the proper background for any course in historical geology. The introductory chapters give the natuure of the earth record, the methods of analysis, and the problems involved in the interpretation of the earth's history. The remaining chapters discuss the interplay between the mobile and immobile belts in the evolution of the continents. The geologic history of each continent is presented in regard to the changing spatial distribution of rocks. The paleontological record for each era is discussed in terms of the evolution and distribution of fauna and flora and also in relation to the physical history of the earth. The text contains 462 illustrations and 23 charts.

The Impossible Journey of Sir Ernest Shackleton. William Bixby. 208p. $3. Little, Brown and Company, 34 Beacon St., Boston, Mass. 1960.

This book tells the story of Shackleton's incredible trip from the Antarctic Continent towards survival. It is a tribute to Shackleton's leadership, to his crew's ability to fight for survival and to one of the great adventures in modern history. This is adventure at its best. Recommended for junior high science students.

The Forest and the Sea. Marston Bates. 216p. 50¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1960.

A paperbound book on a much talked about subject—the relationships of all forms of life to one another. The author compares the life in the sea to the tropical forest and how man flourishes in a nature when he is an infinitesimal part of this abundant life. It is an interesting and a well-written book on nature and the ecology of man. Recommended for both students and teachers of high school biology.

Who Lives in the Meadow. Glenn O. Blough. 48p. $2.50. McGraw Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1961.

A story of animals that live in the meadow. A highly interesting elementary book that should thrill all young nature lovers. This exciting book shows you where to find such animals as the rabbit, snail, ant, woodchuck, woodpecker, and the crayfish. Colorful and accurate pictures shows how the various animals are adapted to their environment. A book that all elementary students will enjoy.

About Chemistry. Magnus Pyke. 214p. $4.50. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y. 1960.

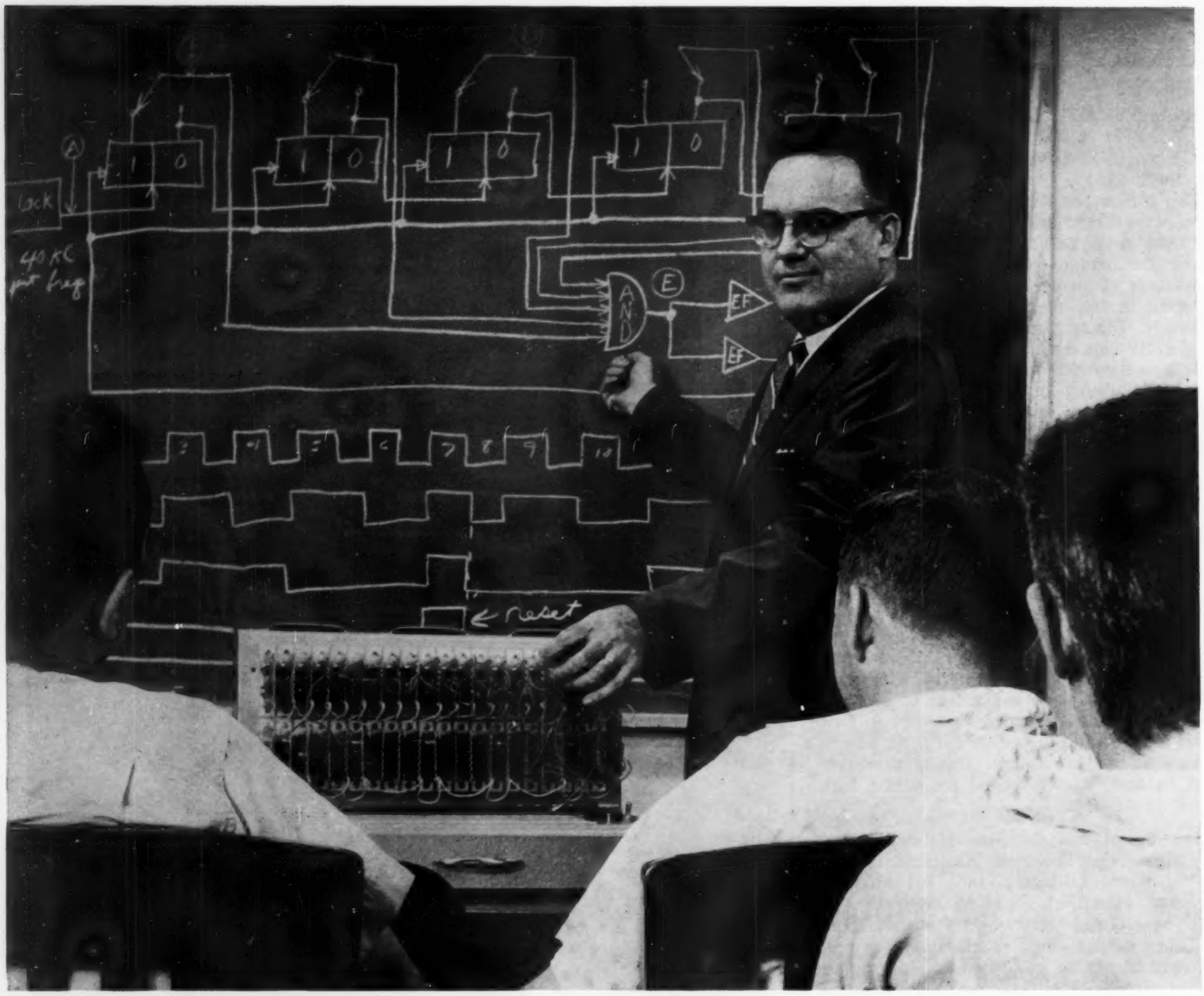
Content deals with: chemical reactions, chemistry and metals, catalysts and chemistry, carbon chemistry, biochemistry, plastics, and atomic energy. Covers a vast quantity of material. Some very difficult concepts are explored. Such concepts as pH, electron structure, catalysis, chromatography, ionization, redox, plastics, and an introduction to organic chemistry are covered in some detail. An interesting book, but the author attempts to cover too much material. It would be extremely useful to the high school chemistry teacher who wishes to interest advanced, capable students in pursuing the further study of chemistry. It will serve to answer basic questions about many fields of chemistry.

Superpower. Revised Edition. Frank Ross, Jr. 184p. $3. Lothrop, Lee and Shepard Company, Inc., 419 Park Ave., South, New York 16, N. Y. 1960.

A well-written short work in which the author gives the whole thrilling story of atomic energy. He stresses that more important than the weapons is the Atoms for Peace Program. Reference here is made to discussion of superpower for agriculture, industry, medicine, and research which represent the goals to be considered in the future.

Alchemy to Atoms. Ellsworth Newcomb and Hugh Kenny. 128p. $2.95. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1960.

A historical development of chemistry from the earliest alchemist to today's atomic scientist with a glimpse of the chemistry of the future. As the book unfolds, the famous men along the path are cited and their contributions to the sciences discussed. Simple, understandable language is used with concise diagrams and drawings.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The Mechanism of Evolution. W. H. Dowdswell. 104p. 95¢. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.

A volume in the Harper Torchbooks, The Science Library Series. Contents include: Darwinism and Some Historical Aspects of the Modern Theory of Evolution; Some Aspects of Variation; Natural Selection; The Experimental Study of Evolution; and The Present Status of Evolutionary Theory. Covers the historical development and selection, Mendelian inheritance, and mutations. The various aspects of the Modern Theory of Evolution are clearly explained and illustrated by simple and well-chosen examples. Would be a valuable addition to a biology teacher's reference shelf and helpful to the advanced college student. Considerable background in botany, zoology, and genetics required for best comprehension.

Laboratory Workbook for Basic Physics. Alexander Efron. 216p. $2.50. John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. 1961. Soft binding.

A well illustrated, comprehensive, and conventional set of high school physics experiments is contained in this publication. The arrangement of the text is not conventional. After an introduction covering molecular phenomena and heat, the text presents an integrated section on fluids, wave motion, sound, light, and introductory electricity. This is followed by experiments in mechanics and additional ones in electricity. Only one experiment in modern physics, "The Geiger Counter," is included.

On the Nature of Man. John Langdon-Davies. 224p. 50¢. A Mentor Book, The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1961.

Interesting and thought provoking reading. Using logic, the author attacks many of our present ideas and attitudes. Points out that knowledge about ourselves has not kept pace with progress in physical science. Treats such topics as scientific thought, evolution, hypnosis, and extra sensory perception.

Exploring Under the Earth. Roy A. Gallant. Illustrated by John Polgreen. 118p. $2.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

This is the story of geology and geophysics. The book unfolds naturally showing the evolvement from superstition and casual observation to the disciplined science it is today. The reader learns how the earth and its atmosphere may have been formed, about undersea mountain chains, and about the forces of erosion which are constantly changing the face of our planet.

What Does an Astronaut Do? Robert Wells. 64p. $2.50. Dodd, Mead and Company, 432 Fourth Ave., New York 16, N. Y. 1961.

This book provides a glimpse into the future of space science. Particular attention is given to the role of the astronaut. Future space vehicles and space stations are also described and an interesting speculation about the future of man's quest to conquer space is included. Recommended for upper elementary and junior high school science classes.

The Wonderful World of Transportation. Laurie Lee and David Lambert. 94p. $2.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

An up-to-date account of transportation from when man's ancestors took their first upright steps on the ground to travel in space. Covers such topics as: Man Must Move, Man Travels Over the Land, Man Spans the Oceans, Man Explores the Air. Recommended for upper intermediate grades and junior high school.

The Web of Nature. Ted S. Pettit. 56p. $2.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N. Y. 1960.

The book has ten chapters which include: The Web of Nature, Why Plants Grow Where They Do, Plants and Animals Live Together, Water, Marsh, Prairie, Desert, Coniferous Tree, and Deciduous Tree Communities. Well illustrated and an excellent source of material on wildlife and conservation. Some of the topics discussed include soil profiles, soil formation, the evolution of climax communities, the dependence of animal on plant life, the effects of climatic conditions on plant and animal life, and how man has changed the plant and animal communities.

Life in the Shifting Dunes. Laurence B. White, Jr. 84p. $1.85. Museum of Science, Boston, Mass. 1960.

Subtitle of this paperback, "A popular field guide to the natural history of Castle Neck, Ipswich, Massachusetts" describes this handy little volume well. Five line drawings included with each group or species illustrated. Good treatment of ecology of both plants and animals of the dunes. Simple, easily read, interesting. Written for a limited area but probably useful in many other similar habitats. Useful source of information for a biology teacher unfamiliar with a dunes habitat.

How to Know the American Marine Shells. R. Tucker Abbott. 222p. 75¢. The New American Library of World Literature, Inc., 501 Madison Ave., New York 22, N. Y. 1961.

A paperbound book that should be interesting to the amateur conchologist. Answers such questions as: "What are sea shells and how are they formed?" "How do you form a shell club and keep it active?" Book is of an appropriate size that the collector can carry it with him at the seashore and use it as an inexpensive guide. Divided into two parts: "The Natural History of Sea Shells" and "Identification of the Sea Shells of Canada and the United States." The book is well illustrated with line drawings and colored plates. Excellent for identification of sea shells.

Space Volunteers. Terrence Kay. 136p. $2.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.

Provides interesting descriptions of the work of men who are space pioneers. To describe a few, they are: test pilots, astronauts, ejection seat riders, members of atomic balloonists groups, and many others. A book with a different approach attempting to integrate all of the efforts to break through the space frontier. Recommended for junior high school level.

Map Making: The Art that Became a Science. Lloyd A. Brown. 218p. $4.75. Little, Brown and Company, 34 Beacon St., Boston 6, Mass. 1960.

A laudable attempt to present the story of maps so that the reader will find the story of maps and the men who made them. Includes some art, history, religion, politics, and a great deal of science. The author brings out the fact that the search for the right answers is still going on, that scientists are still learning new things about the size and shape of the earth. Illustrated with excellent drawings.

Henderson's Dictionary of Scientific Terms. Seventh Edition. J. H. Kenneth. 596p. $12. D. Van Nostrand Company, Inc., Princeton, N. J. 1960.

Title misleading since terms taken not from all sciences but only from biology, anatomy, and zoology. Perhaps better titled Dictionary of Biology. This does not detract from its usefulness for its special purpose. Contains over 15,600 definitions, derivation of terms given, and pronunciation. Multiple definitions given where appropriate. Useful on the reference shelf of the biology teacher. Not too difficult for high school biology students.

Polarization of Light—Basic Theory and Experiments. Hollis N. Todd. 52p. Paper, wire bound. $1. Pioneer Scientific Corporation, 645 St. Paul St., Rochester 2, N. Y. 1960.

An excellent source for the science teacher. Good discussion of light as a form of energy plus excellent coverage of polarization. Covers retardation, refraction, birefringence, as well as polarization. Line drawings illustrating many points are well done and helpful to beginning physics students as well as to a teacher. Section describes Pioneer Scientific Corporation's polarization equipment. Descriptions of eight experiments using polarized light are included. This booklet is worth much more than its price indicates. Recommended for high school science teachers and their better students.

Basic Mathematics of Science and Engineering. Reuben E. Wood. 200p. $2.50. The Sigma Press Publishers, 2140 K St., N.W., Washington 7, D. C. 1960.

A brief book written in question-answer form. The author tries to help the beginning student in engineering and science to review or learn important "methods and principles in: arithmetic, logarithms, algebra, geometry, trigonometry, infinite series, and calculus." The attempt is to produce a book small enough so that the "student could work through it rather rapidly." This is an inexpensive, hardback, handy reference which could be useful to many applied scientists

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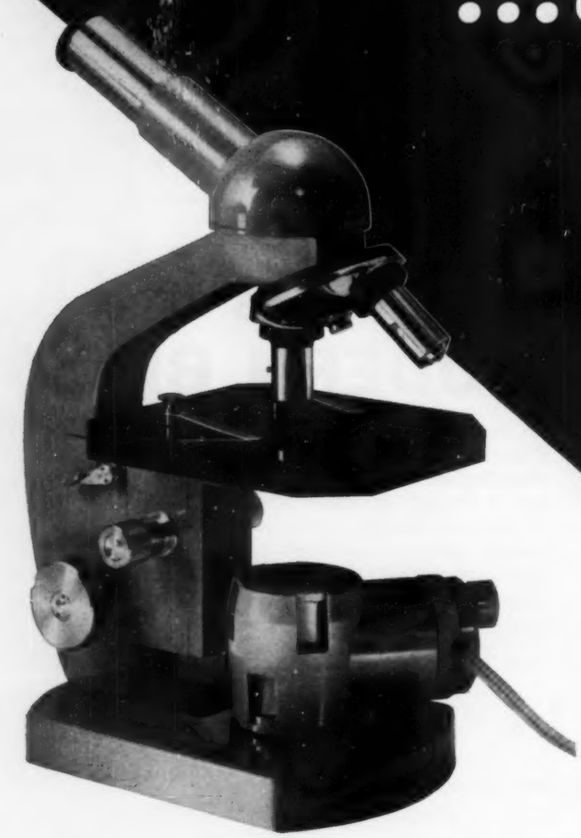

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PROFESSIONAL READING

"A New Element Is Born." By Homer Page. *Think,* 27:2-5. September 1961. A narrative of an interview with the discoverers of element number 103, Lawrencium. The problems, the machinery, and the reward of discovery are all described. The "team" effort in today's scientific research is well illustrated. Pictures are used abundantly to demonstrate the team approach to research.

"What Science Knows about Your Biorhythms." By Howard Simons. *Think,* 27:25-7. September 1961. ". . . rhythmicity is the rule of living things." So says Dr. Frank A. Brown of Northwestern University. The article reviews the findings of many specialists who have worked in this field. The effect of jet travel on humans, the phenomenon that a full moon affects the birth time of babies in New York City, and the "clocks" which govern the annual behavior of some animals are examples of the type of material reviewed in this article. Annual, lunar, and daily biological rhythms are reviewed and discussed.

"Junior High School Curriculum Series." School of Education, Cornell University, Ithaca, N. Y. Single copies 25¢; Multiple copies 20¢. Presents a compilation of government publications useful to teachers of English, social studies, mathematics, and science at the junior school level. Selected from announcements appearing over a five-year period (1956-60) and classified under main topics with limited cross-referencing. Numerous publications in agriculture, home economics, industrial arts, and business are included. The larger number of titles pertain to science and social studies, rather than the other categories.

"Fine Particles Research . . . Things Small, Effects Big." *Journal of the Stanford Research Institute,* Third Quarter, Volume 5, 1961. 40p. Single copies. Fine particles play an important part in our daily activities which extends from powdered bleach to powdered cream. Particle technology, as well as particles in health, in disease, in the atmosphere, and in agriculture are all treated. The publication is attractively illustrated and written in a fluid, easy reading style. This interesting booklet contains many student reports and project ideas.

"Current Teaching—Machine Programs and Programming Techniques." By Joseph W. Rigney and Edward B. Fry. *AV Communication Review,* 9:3. May-June 1961. Techniques of constructing programs and the major variables that have to be taken into consideration are discussed briefly. Various samples of programs are found in Part II of the publication. Those of interest to the science teacher include Biology, Chemistry, Electronics, General Science, Genetics, Mathematics, Physics, and Statistics. Single copies are available for $2. National Education Association, Department of Audiovisual Instruction, 1201 Sixteenth St., N.W., Washington 6, D. C.

1962 Summer Fellowships

The National Science Foundation plans to award on March 15, 1962 several hundred summer fellowships to experienced secondary school teachers of science and mathematics for one, two, or three summers. This is a separate program from the NSF summer institutes. Candidates for fellowships must pursue a program of *graduate-level* work in the mathematical, physical, or biological sciences that is acceptable by the fellowship institution of the candidate's choice toward an advanced degree in any of the subject-matter disciplines. Choice of program of study is important, especially if no course listings are available at application time. Information and application forms may be obtained from Secondary School Fellowships, American Association for the Advancement of Science, 1515 Massachusetts Avenue, N.W., Washington 5, D.C. Application closing date is **January 2, 1962.**

AUDIO-VISUAL AIDS

The Earth: Its Atmosphere. Film covers composition and structure of the atmosphere; also weather, the ionosphere, and discusses atmospheric research with satellites. Covers effects of motion of the atmossphere on the earth's surface. Also relates atmospheric movements to the circulation of the earth's water supply. Section on layers of the atmosphere is well done. Film also covers causes of winds, weather instruments, ionization in the atmosphere, and weather satellites. Although the discussion of weather satellites is brief, the film develops many ideas related to their function and use by man. Recommended for science students in intermediate grades and junior high school. Would be appropriate in earth science classes. 11 min. Color $110, B&W $60. 1961. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

First Adventures in Space. Six color filmstrips with following titles: What Is Space, 31 frames; Rockets to Space, 30 frames; Getting Ready for a Space Trip, 29 frames; What Are Satellites?, 28 frames; What Are Space Stations?, 28 frames; and A Space Trip to the Moon, 30 frames. This series, developed for primary and elementary grades, should help answer many questions posed by children. The concept of space is well described and includes a description of the heavenly bodies. The description of the firing of a rocket plus the orbiting of its payload is well done. Simplified but accurate and interesting treatment of space suits, satellites, and space stations are included. The portion of this series which describes the method of launching and orbiting a satellite is especially well done. Information on the moon including conditions there plus their effect upon man would be most useful in these times of contemplated "moon shots." Highly recommended for science in the primary grades. Individual filmstrip, $5.75. Set of 6, $31.50. 1961. Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich.

Fish and their Characteristics. Film covers fish as a class including both a description of those characteristics which are common to all members of the class and adaptations illustrated by different species within the class. Underwater photography is excellent. Animation is used to illustrate certain points. Film utilizes a good technique in that it relates structures in less familiar forms to those in a better known species. Film also discusses following topics related to fish: variety of form, economic importance of the group, fish conservation, reproduction, and migratory fish. The film is recommended for science students, both at the upper elementary and junior high level. 11 min. Color $110, B&W $60. 1961. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Cotton in Today's World. Producer recommends this as a film appropriate for social studies. Would be useful in science classes to illustrate an economically important crop. Historical development of cultivation of cotton well portrayed. Shows modern mechanization in production of cotton and gives locations of major cotton growing areas. Also, illustrates variety of uses of cotton fibers. Useful in relating physical science to biological science. 11 min. Color $110, B&W $60. 1961. Coronet Instructional Films, Coronet Building, Chicago 1, Ill.

Understanding the Atmosphere. Six filmstrips with titles: The Physical Characteristics of Air, 40 frames; What Is Air Pressure, 44 frames; Air Works for Man, 34 frames; The Composition of Air, 43 frames; The Importance of Air in Nature, 41 frames; The Earth's Atmosphere, 37 frames. Includes not only good coverage of concepts but suggests activities. Covers: expansion and contraction, relation of molecular movement to pressure, the gases of the air, uses of air by man, the behavior of the gases which constitute air, and considerable coverage of the layers of the atmosphere. These are good, color filmstrips which cover both chemical and physical aspects of air. Producer recommends placement at junior high level. However, probably useful in upper elementary grades as well as for less capable sections of senior high science. Individual filmstrip, $5.75. Set of 6, $31.50. 1961. Jam Handy Organization, 2821 East Grand Blvd., Detroit 11, Mich.

Muscles and Bones of the Body. Story centers around a young boy and his older

brother who is a medical student. Youngster has model torso and asks questions of older brother. Film shows different types of muscles, bones, and joints. Describes function of parts and proposes good health rules. Good sequences show muscle tissue, and illustrate electrical stimulus and response of a frog's leg muscle. Shows heart muscle. Characterizes the three types of muscles. Recommended for health classes and for science classes in intermediate grades. 11 min. Color $110. B&W $60. 1960. Coronet Instructional Films, Coronet Building, 65 East South Water St., Chicago 1, Ill.

Science Adventures in Astronomy. A new set of four color filmstrips for grades 4 to 6. This is the second filmstrip series developed by Catherine Barry, astronomer, Hayden Planetarium, New York City, and Leonard S. Davenport, science consultant at the Roslyn, New York public schools. A series with separate films devoted to: The Sun, The Moon, The Stars, and The Planets. With the teacher's help and the guide materials available with the filmstrips, essential principles at the elementary level can be introduced in the intermediate grades. Color. Set $20. 1960. Filmstrip House, 432 Park Ave., South, New York 16, N. Y.

The Inquisitive Giant. A British film which shows the construction of the new giant radio telescope at Jodrell Bank, England. British commentary may pose problems for American listeners. Film's greatest asset is its complete, step-by-step, coverage of the astronomer's first idea of the proposed construction, subsequent planning, laborious building, and finally completion and use of the radio telescope. Excellent treatment of cooperation between scientists in planning and technicians in constructions of the instrument. Explains how man can now receive, with the radio telescope, a new type of message from outer space. Illustrates how this instrument may be used also to map the heavens. 28 min. B&W $125. 1960. Contemporary Films, Inc., 267 West 25th St., New York 1, N. Y.

Electricity: How It Is Generated. Shows how electricity is transmitted to our homes for use. An electric circuit is explained by means of a battery, wiring, and a galvanometer. The relationship between electricity and magnetism is explained using the historical experiment of Michael Faraday. The pattern of lines of force of a magnet is shown by use of iron filings. A model electric motor is used as a generator to produce electricity. Circuits are traced when using slip rings to produce AC current and a commutator to produce DC current. Various methods used to drive generators are shown including water turbines, steam power, and atomic power. For grades 4-9. 11 min. Color $100, B&W $50. 1960. Coronet Films, Coronet Building, 65 East South Water St., Chicago 1, Ill.

Classifying Plants and Animals. Film presents the difficult aspect of classification in an easily understood manner. Uses examples within the student's own environment. De-

velops a brief history of classification. Explains well why classification is necessary for orderly scientific work. Commentator uses clear, concise, and yet simple language. Review at end of film provides a good summary. Recommended for high school biology or ninth grade science. 11 min. B&W $60. 1961. Coronet Films, Coronet Building, 65 East South Water St., Chicago 1, Ill.

Conquest of the Atom. A British narrated film best used as an introduction to the atom and its structure for high school chemistry or physics. An excellent feature of the film is its introduction to the scientists that developed the ideas of the atom. Chadwick Thompson and others are discussed along with excellent animation of atomic structure. Historical development well done. Recommended for senior high students. 30 min. Color $195. 1960. International Film Bureau, 57 East Jackson Blvd., Chicago 4, Ill.

Wonders of Plant Growth. Pictures how a plant grows through media of timelapse photography. Uses boy and girl as subjects who demonstrate methods of growing plants from seeds, roots, stems, and leaves. Should motivate the student to try the various methods in their homes. An excellent film for elementary science, grades 1-4. 11 min. Color $110, B&W $60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

What's Inside the Earth. Well organized film showing how man has penetrated the earth's surface. Animated diagrams are mixed with live photography to illustrate the structure of the earth's interior by use of wells, mines, oil wells, and volcanoes. Illustrates how a seismograph determines type of material encountered in the various layers of the earth. Layers are well illustrated and explained. For grades 5 to 9. 15 min. Color $135, B&W $70. 1961. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Crayfish Anatomy. An excellent film on the procedure used in dissection of a crayfish. First portion of film shows and explains the external anatomy of the crayfish but major portion is devoted to the actual procedure of dissection. The techniques used and explanations given are excellent. Useful aid to high school and college teachers of biology. 11 min. Color $100, B&W $50. 1960. Indiana University, Audio-Visual Center, Bloomington, Ind.

Sound for Beginners. This film is designed for elementary study of sound. Vibration is the source of sound. Uses everyday examples to illustrate this concept. Indicates how sound travels through the atmosphere by the use of a tuning fork. Experimentally proves the fork is vibrating. Demonstrates how long it takes for sound to travel through air and illustrates the transmission of sound in other media. Finally, as a review, the film treats some of the physical properties of sound and how they aid in recognizing different sounds. 11 min. Color $110, B&W $60. 1961. Coronet Films, Coronet Building, 65 East South Water St., Chicago 1, Ill.

High Arctic: Life on the Land. The film is best described by the introduction which states: "From the roof of the world—a film report on life as far north as it can be lived." An excellent ecological treatment of the life in the arctic photographed on Queen Elizabeth Islands within the Arctic Circle. Includes photography of the infrequently shown musk-ox. Describes in detail methods for survival used by plants and animals in the Arctic. Changes in plant and animal populations with changes of weather well portrayed. Life cycle of the lemming and the Arctic hare is described. Use of the northern areas as nesting sites for migratory water fowl illustrated. Recommended for high school biology and for lay groups learning about ecology and conservation. 22 min. Color $240, B&W $120. 1960. National Film Board of Canada, 680 Fifth Ave., New York 19, N. Y.

Adventure in Science: The Size of Things. Proportion, as associated with volume, cross-section, strength, and weight is presented in animation. The film questions Gulliver's truthfulness in the book, *Gulliver's*

Travels, presents the facts, then allows the viewer to draw his own conclusion. Effect of doubling dimensions is shown clearly by using sugar cubes. The size-strength ratio is represented by a skeleton-bone sequence. An elephant, mouse, beetle, and boy are used in an entertaining manner in showing effects of changing size. For junior high students and senior high students in mathematics, shop, general science, and physics classes. 11 min. Color $110, B&W $60. 1960. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

Earthworm Anatomy. Excellent film on the techniques and procedures used in the dissection of an earthworm. Explanation given to all steps in the dissection process. Excellent photography will make the classroom teacher's job much easier and more effective. It is highly recommended for all high school and college teachers of biology. Probably most useful at high school level. 11 min. Color $100, B&W $50. 1960. Indiana University, Audio-Visual Center, Bloomington, Ind.

Fire Science. The film is an introduction to the chemistry of combustion. The historical background of fire includes primitive man's use of fire for cooking and the baking of clay utensils, making of metal implements during the Bronze Age, operation of Hero's engine, and how we have learned to use fire. Animation is used to illustrate the molecular action of a burning fuel whose carbon and hydrogen atoms combine with oxygen to form carbon dioxide and water, releasing energy in the form of heat and light. Experiments explain the concepts of fuel, oxidation, kindling temperature, and spontaneous combustion. A number of demonstrations are shown which would be difficult or dangerous to reproduce in the classroom. The film ends with the theme that fire under control is one of man's greatest servants. For upper elementary and junior high. 15 min. Color $165, B&W $90. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Black Widow Spider: Her Life Cycle and Her Enemies. A close-up view of the black widow's life. Full life cycle of the male and female widow is followed from mating through moulting. Time-lapse photography is employed in some instances. How to recognize the spider and web and interesting size comparisons are featured. Praying mantis, alligator lizard, and fly (complete life cycle) are also shown as enemies of the widow. Background music is dramatically used. For grade 4 and beyond. 12 min. Color $120. 1960. Ken Middleham Productions, P. O. Box 1065, Riverside, Calif.

Exploring Your Growth. By using animation and photomicrography, the film explains how we grow. It explains digestion in the mouth, stomach, and intestine, and how digested food enters the blood stream and then is transported to the cells. Animation and narration are excellent. Film can be used in grades 4-7 science and health classes. 11 min. Color $110, B&W $60. 1960.

Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Wonders in Your Own Backyard. Boys and girls are made aware of some of the animals found in their own backyard. The film shows the earthworm, spider, snail, millipede, and sow bug. It shows how these animals move and obtain food. The importance of these animals to man is well illustrated. For elementary science, grades 1-6. 10 min. Color $110, B&W $60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

The Redwood Trees. Film illustrates the trees as remarkable creations of nature and as an important lumber resource. Covers both U. S. West Coast species, *Sequoia sempervirens* and *Sequoia gigantea* as well as the *Metasequoias*, or Dawn Redwood, of China. Ecology of the species is well portrayed. Forest ecology of the redwood forest also well presented. Reasons for intelligent conservation also presented without sentiment. Good introduction to species characteristics. A fine film which should add greatly to biology classes in regions other than the West Coast. Would also be of interest to the general public, vacationing Americans, and anyone interested in nature. 15 min. Color $160. 1960. Arthur Barr Productions, 1265 Bresee Ave., Pasadena, Calif.

The Story of the Mourning Dove. A dramatic and skilled depiction of the life history and sporting qualities of the mourning dove. Excellent scenes of nesting, feeding, live trapping, banding, and habitat filmed in the outdoors. The story is woven around the life of one particular bird and includes fine sequences of environmental factors, hunting, and the work of the game biologist. Recommended for biology, ornithology, and conservation classes. 38 min. Color $245. 1960. Missouri Conservation Commission, Jefferson City, Mo.

Snakes—Friends and Foes. An excellent film showing the identifying features, habits, and values of snakes. Includes the poisonous copperhead, cottonmouth, and a number of rattlesnakes clearly depicting the eye, pit, bottom plate, and fang characteristics which distinguish these snakes from the harmless species. Some of the other snakes shown are the hognose, king, green, and pilot black. Dramatic scenes of snakes eating frogs, chicken eggs, and taking a rat. Recommended for high school and college biology classes. 23 min. Color $150. 1960. Missouri Conservation Commission, Jefferson City, Mo.

Insect Collecting. Film shows the most common methods of collecting day-flying, microscopic, and aquatic insects. Methods for collecting nocturnal specimens also included. Shows how to recognize and collect immature forms of insect life, such as: eggs, larvae, and pupae. Film should stimulate a desire in young or old to attempt the collection and preservation of insect life. Recommended for grades 6-12. 14 min. Color $135. 1960. Pat Dowling Pictures, 1056 South Robertson Blvd., Los Angeles 35, Calif.

APPARATUS & EQUIPMENT

The Instructor Primary Science Concept Charts. "Simple Chemistry." Designed for kindergarten and primary grades. Packet contains 12 wall charts (13 x 16 inches), plus a teacher's guide. Chemistry packet covers water and its properties, energy from food, uses of the senses, and oxidation. Teachers guide, well written, describes use of chart. Charts' titles indicative of content: Solids, Liquids, Gases, Some Solids Dissolve, Liquids Boil and Freeze, Water Is Absorbed, Soap Helps, Some Materials Burn, Fires Need Air, Iron Rusts, Food Gives Us Energy, We Find Out, Chemical Change, and Physical Change. Treats a topic appropriately which is not traditionally covered in lower grades. Recommended for the busy elementary school teacher who needs an organized unit on chemistry for early grades. $2.50. 1961. F. A. Owen Publishing Company, Dansville, N. Y.

Pioneer Vertical Polariscope. An excellent addition to the physics classroom and laboratory. Might be used also to good advantage in general science or physical science classes. Metal, circular in cross section, base is about 5½ inches high. Contains lamp with cord for 115-volt circuit. Base vented to maintain lower temperatures. Top of base has glass polarizing screen, 4 inches in diameter. Specimens may be placed on this horizontal polarizing screen. Screen will accommodate specimens up to 8 inches in diameter. Analyzer, with glass polarizing plate of 4-inch diameter is mounted on a metal, vertical rod. The analyzer can be moved vertically to accommodate specimens up to 5 inches in height. Analyzer equipped with spring clips. Construction sturdy and hence should take hard use and abuse. Extra sheets of polarizing material in appropriate sizes are available from the factory. $59.50. Catalog No. 62-60. 1961. Pioneer Scientific Corporation, 645 St. Paul St., Rochester 2, N. Y.

Bausch and Lomb Microscope No. 31-21-28-22. A standard student microscope, gray-colored with a black stage. Fixed 10X eyepiece, with revolving closed, dust-proof system, 2-objective turret. Objectives of 10X (.25 NA) and 43X (.55 NA) are parfocal and color-corrected and lock in position easily. Focusing lock corrects for accidental slide breakage. Stage size adequate. Substage revolving aperture disc diaphragm with 4 apertures for light control. Model tested provided with a one surface concave mirror, movable in 2 planes. Focusing knobs on both sides; coarse adjustment on upper arm, fine adjustment on base. Tube stop prevents accidental disengaging of ocular tube from arm. Prefocusing gauge on arm provides unique method for ease in

focusing. Model No. 31-21-28-22. $112.50 in lots of 5. $125. each. 1961. Bausch and Lomb, Inc., Rochester 2, N. Y.

Bausch and Lomb Microscope No. 31-21-29-27. A student microscope of outstanding quality. Meets or exceeds all the requirements of the NDEA. This scope is equipped with a revolving nosepiece containing three color coded (3.5X, 10X, and 45X) objectives. The 3.5X-scanning objective is useful both for locating structures on the slide and for viewing larger objects. The excellent parfocal objectives are fixed to a vertical tube which is equipped with a prefocusing gauge, a mechanical stop to prevent removal of the tube, and a fixed 10X eyepiece. When provided with the optilume built in light source, the revolving stage diaphragm does not provide adequate light control. An iris diaphragm might be more appropriate, and is available at extra cost. The large 4.5 by 5.5 inch stage is provided with spring clips; stage tilts by means of a nylon axle insert rather than the ordinary arm and pinion. A durable piece of equipment with fine resolution and good color transmission. Scope recommended for general student use in high school biology. Model ST. $154. 1961. Bausch and Lomb, Inc., Rochester 2, N. Y.

Weather Observatory. Contains barometer with attached thermometer, anemometers, wind vane, wind direction and velocity indicator, rain gauge, sling psychrometers, maximum and minimum thermometers, and an instrument shelter. Complete weather station for the high school earth science course. Materials of high quality. Price list on individual items available on request. Complete observatory $606.38. 1961. Henry J. Green Instruments, Inc., 2500 Shames Drive, Westbury, N. Y.

A O Spencer "Microstar" Model M2 M5-M1. Not priced in the student microscope class. This durable, well-engineered microscope would be excellent for teacher demonstrations. This gray model, features an inclined tube in turret mount. The coarse and calibrated fine adjustment, iris diaphragm, and adjustable light source which may be detached are of fine quality. The eyepiece, 10X magnification, is not fixed. Nosepiece moves freely and is spring locked. Objective lenses, 10X and 43X, are parfocal. Both magnifications give excellent resolution. The stage, of generous size, has removable spring clips. The tube is inclined, hence, a pinion and arm adjustment is not necessary. Model M2 M5-M1 $417 each (1-4), $375.30 (5 or more). 1961. American Optical Company, Instrument Division, Buffalo 15, N. Y.

A O Spencer Standard Monocular Microscope No. L60PD-S1. A dove-gray colored standard student microscope with an inclined turret type monocular tube. The new coaxial low positioned coarse and fine adjustments have much to be desired. The entire focusing mechanism is protected against dust and foreign particles. Nosepiece is movable, with two objective lenses, 10X (NA .25) and 43X (NA .55) that are parfocal and parcentered. Provides field curvature, astigmatic, chromatic, and comatic corrections with adequate low and high power focusing. A fixed eyepiece (10X), with a pointer, is one of the more notable features. Stage is of adequate size, with an aperture disk diaphragm with five openings and sturdy non-removeable and adjustable spring clips. Optional, built-in substage illumination with no mirror, provides adequate light. Inclined reversible body and base is very sturdy with an even distribution of weight. A rugged microscope that should take years of student use. The entire stand is one rigid, sturdy unit and the base protects the stage, nosepiece, and objectives against accidents. The model is recommended as a student microscope for use in high school biology or botany or zoology and related course work. $125 (1-4), $112 (5 or more). 1961. American Optical Company, Instrument Division, Buffalo 15, N. Y.

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